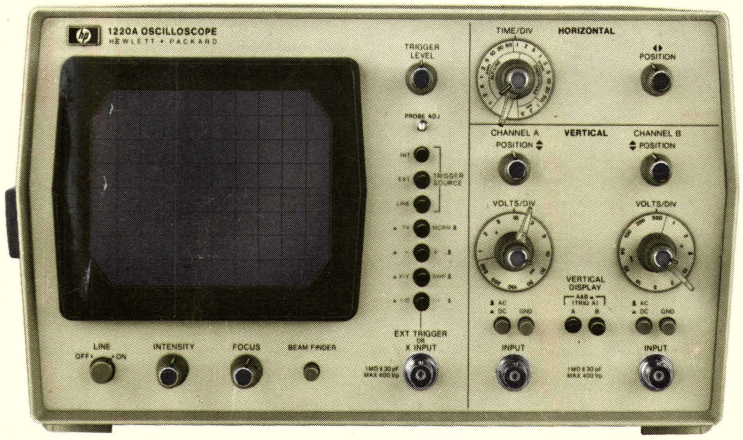
OPERATING AND SERVICE MANUAL

OSCILLOSCOPE 1220 A AND 1221 A



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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the US National Bureau of Standards to the extent allowed by the Bureau's calibration facilities or to the calibration facilities of other International Standards Organization Members.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

PREFACE

One copy of this manual is supplied with each instrument. Additional copies may be purchased from the local Hewlett-Packard Sales and Service Office. Specify the instrument model number and serial number. A microfiche version of this manual is available under part number 01220–90501.

Reference should be made to the manual change sheets supplied with the manual for errata and technical changes.

Technical changes are indicated by the prefix (the first five characters) of the serial number which appears on the rear panel of the instrument; the serial number prefix of the instrument to which this manual applies directly is:

1322G

for serial number 00381 on (for Model 1220A)
and 00221 on (for Model 1221A)

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01220–90001

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SECTION 1

INTRODUCTION

1–1 Your new Hewlett-Packard Model 1220A or 1221A Oscilloscope is produced using the same construction and design techniques used to achieve laboratory instrument measurement accuracy. You can rely on this instrument for long, dependable, accurate operation wherever you use it and whatever the conditions under which you use it.

1–2 Special effort has gone into the design of your Oscilloscope to make it easy to use. Front panel controls are separated into logical groupings; each group is identified, and so is each control in the group. Latching pushbuttons are used to make it easy to change modes of operation, with ample finger-space allowed.

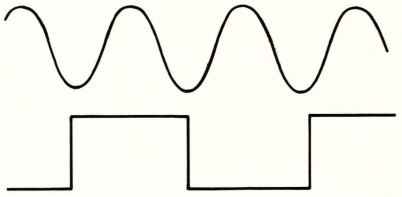
1–3 Controls and connectors less frequently used are placed on the rear panel: Line voltage selector switches; fuse holder; Z-input (intensity modulation); power source for camera adapter; and convenient ground connector.

1–4 Easy servicing is ensured by the use of only four circuit modules: Trigger circuit board (horizontal or sweep circuits); Amplifier circuit board (vertical circuits); High Voltage circuit; Heat Sink Assembly (primary power input). All assemblies are removable for servicing, as is the CRT (cathode-ray tube). Full instructions for assembly removal are provided in the Maintenance section.

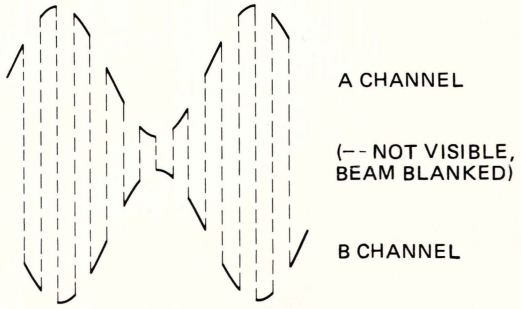
1–5 Specifications are shown in Table 1–1. Vertical deflection sensitivities, horizontal sweep speeds, risetime, and bandwidth response are ample for tests required in servicing black-and-white or color television receivers, AM or FM radio receivers, tape recorders, or any other electronic equipment of similar nature. Synchronization is possible from TV line or frame.

In addition, the 1220A allows two signals to be compared. The affect of a dual trace display being achieved by automatic 'alternate' and 'chop' switching. Briefly, here is a description of how this works:

Alternate display mode shows a display of each vertical channel input signal on alternate sweeps. Let's suppose a sine wave is applied to Channel A input and a square wave to Channel B input. The first sweep will display the sine wave, the next sweep will display the square wave, the next displays the sine wave, and so on. Notice that this display mode is automatically selected in sweep speeds of 0.1μs/cm to 500μs/cm.



Chop mode is effective at sweep speeds below 1ms/cm and the display is developed by the sweep circuits switching from one input to the other very rapidly. Persistence of the CRT phosphor glow and visual persistence of the viewer build a continuous display of both channels. This phenomenon is illustrated in the following diagram (in this cases two sine waves are applied).



These two methods of display are automatically chosen when you select sweep speed and make it possible for you to see two complete signals simultaneously without undesirable flicker.

1–6 Note that the terms "sweep" and "trigger" are two entirely different things. "Sweep" refers to the constant rate of travel of the beam, or trace, horizontally across the display area. It is governed directly by the setting of the horizontal TIME/DIV control. "Trigger" determines the timing of the start of each sweep and does not necessarily occur at regular intervals.

1–7 Items supplied with your Oscilloscope are:

Power Cable: 3-wire, removable. Cable plugs are provided for receptacles commonly found in your area.

Fuses: One 0.5 ampere fuse for 100/120V operation.
One 0.25 ampere fuse for 220/240V operation.

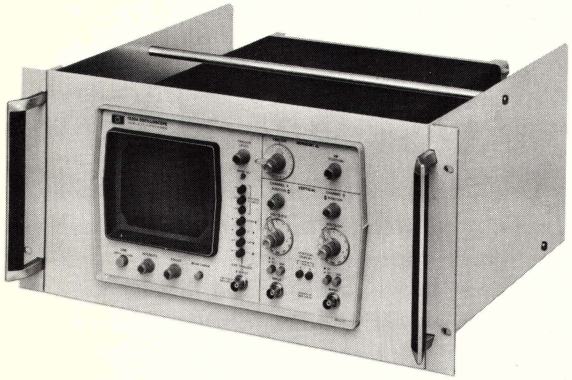
Light Filter: Blue.

Operating and Service Manual.

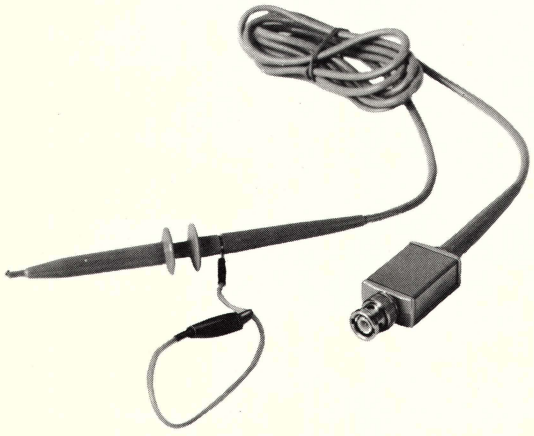
Operating Instructions in German, French and Italian, part number 01220–90002

Other accessories available:

Rack Mount Kit: 8 3/4-in. x 19-inch, HP Model 10119A.



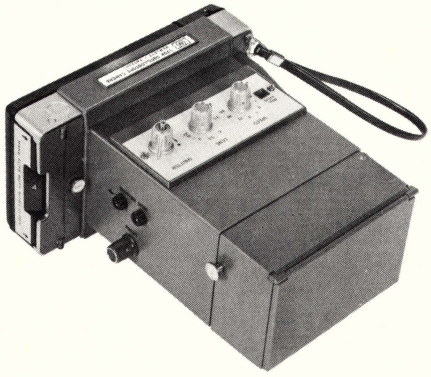
Attenuator Probe: compensating, 10:1 attenuation ratio, HP Model 10013A;



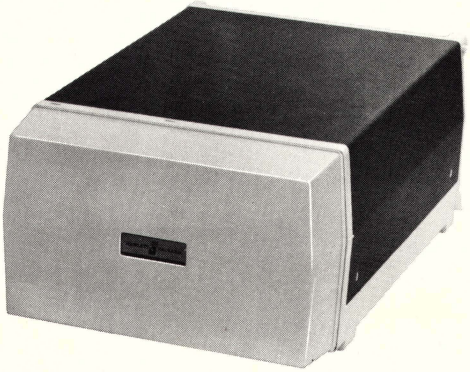
BNC/Banana Plug Adapter: HP Model 10110A.

Camera: HP Model 123A (requires Camera Adapter).

Camera Adapter: HP Model 10373A.



Front Panel Cover: with accessory storage compartment, HP Model 10117A.



Viewing Hood: HP Model 10116A.

Table 1–1. Specifications (cont'd)

Input RC: 1 megohm shunted by approx. 30pF

X–Y Phase Shift: less than 3^{o} at 100KHz.

CATHODE-RAY TUBE

TYPE: mono-accelerator, 2kV accelerating potential, P31 Phosphor

Graticule: 8 x 10 cm internal graticule; 0.2 div subdivisions on major axes.

Beam Finder: returns trace to CRT screen regardless of setting of horizontal and vertical controls.

Intensity Modulation: +5V (TTL compatible) 2 Hz to 1 MHz blanks trace of any intensity.

Maximum Input: 7V RMS

Input Resistance: approx. 1.5kΩ

GENERAL

Probe Adjust: approx. 0.5 V pp, 2 kHz square wave for adjusting probe compensation.

Power Requirements: 100, 120, 220, 240V + 5, −10% 48 to 66 Hz. Approx. 40W

Weight:
1220A: net 16 lbs (7.3 kg);
shipping 21 lbs (9.5 kg)
1221A: net 15 1/2 lbs (7 kg);
shipping 20 1/2 lbs (9.2 kg)

Dimensions:

Height	170 mm (7.1 in.)
Width	311.2 mm (12.7 in.)
Depth	412.8 mm (16.1 in.)

ENVIRONMENTAL SPECIFICATIONS

Temperature: Nonoperating −40 to $+70^{o}$C. Operating 0 to $+45^{o}$C within specs.

Humidity: to 95% relative humidity at 40^{o}C.

Vibration: vibrated in three planes for 15 min. each with 0.25 mm (0.010 inch) excursion, 10 to 55 Hz.

Altitude: to 4600 m (15000 ft.)

Acessories furnished: 1 power cord, 1 blue light filter, fuses for 100/120 V operation and 220/240 V operation. 1 operating and service manual, operating instructions in French, German and Italian.

OPTIONS

Option 007: CRT with P7 phosphor instead of P31 phosphor.

Option 020: Front Panel in German

Option 021: Front Panel in French

Table 1–1. Specifications

Modes of Operation (1220A only)
channel A; channel B; channels A and B displayed alternately on successive sweeps (alt); triggering by A channel; channels A and B displayed by switching between channels at approx. 200kHz rate with blanking during switching (chop); automatic selection of alternate or chop mode.

Chop: at sweep speeds from 0.5sec/div to 1ms/div;

Alt: 0.5ms/div to .1μs/div.

VERTICAL AMPLIFIERS

(1220A – 2-channel, 1221A – 1-channel)

BANDWIDTH

(50kHz, 50Ω source reference signal giving 6cm vertical deflection)

DC-coupled: dc to 15 MHz (–3dB)

AC-coupled: approx. 2 Hz to 15 MHz (–3dB)

Risetime: approx. 23ns

DEFLECTION FACTOR

Ranges: from 2mV/div to 10V/div (12 ranges) in 1, 2, 5 sequence. ± 3% accuracy with vernier in calibrated position on 10mV/cm to 10V/div ranges. ± 5% accuracy on 2mV/div and 5mV/div ranges.

Vernier: continuously variable between all ranges, extends maximum deflection factor to at least 25V/div.

INPUTS

Input RC: 1 megohm shunted by approx. 30pF.

Input coupling: AC, DC or GND selectable. GND position disconnects signal input and grounds amplifier input.

Maximum Input: ± 400V (dc + pk ac).

TIME BASE

SWEEP

Ranges: from 0.1μsec/div to 0.5sec/div (21 ranges) in 1, 2, 5 sequence. ± 4% accuracy with Expander in calibrated position.

Expander: expands sweep continuously min. 10 times. Usable max. sweep speed is approx. 20ns.

SWEEP MODE

Sweep is triggered by internal or external signal. Bright baseline displayed in absence of input signal.

TRIGGERING

Internal: approx. 10 Hz to 15 MHz on signals causing 1 div. or more vertical deflection.

External: approx. 10 Hz to 15 MHz on signals 0.1Vpp or more.

External Input RC: approx. 1 megohm shunted by approx. 30pF.

Line: triggers on line frequency.

TV Sync: Separator for positive or negative video, 1 div. min. video signal to trigger. Time/div switch selects automatic frame (0.5 s/div to 100μs/div) or automatic line (50μs/div to 0.1μs/div) trigger. Usable also as a low pass-filter.

LEVEL AND SLOPE

Internal: at any point on the positive or negative slope of the displayed waveform.

External: continuously variable from +0.5V to –0.5V on each slope of the trigger waveform (with 20dB-Attenuator: +5V to –5V).

EXTERNAL HORIZONTAL INPUT

Bandwidth: dc to 1 MHz

Deflection Factor.

Expander	X-Mode Attenuator	Deflect. Fact.
CW	1:1	100mV/div
Cal.	1:1	1V/div
Cal.	1:10	10V/div

Continuous adjustment between ranges by Expander.

Figure 2–1. Controls and Connectors

on the viewing area. When the expander is being used, this control makes it possible for you to view either end of the expanded trace, or any point between.

6
HORIZONTAL TIME/DIV. With expander in the calibrated position (fully counterclockwise), markings on this dial indicate the amount of time it takes for a spot on the CRT to travel one horizontal division. This time ranges from 0.1μsec to 0.5sec. Note also that the setting of this control governs the type of display (alternate or chop) in Model 1220A.

7
EXPANDER. In effect, the expander is a horizontal gain vernier. Clockwise rotation allows the trace to be stretched by factors up to 10. This has many applications when a particular point on a waveform is of interest. With the expander out of detent position, sweep speeds do not relate directly to the TIME/DIV switch markings.

8
TRIGGER LEVEL: This control enables the operator to start the sweep at any desired amplitude level on the applied signal.

9
PROBE ADJ. At this point, an internally generated square wave is brought to the front panel where it may be used to compensate low-capacity divider probes. By attaching the probe tip to this point and connecting the probe to a vertical amplifier, the probe compensator may be adjusted to match the oscilloscope input.

10
INT. This pushbutton is pressed to select an internally generated sync signal to trigger the sweep. Pressing this pushbutton releases EXT **11** and LINE **12**.

11
EXT. When pressed this pushbutton allows the Model 1220A/1221A to trigger on an external sync signal applied to EXT TRIGGER INPUT **17**. Pressing this pushbutton releases INT **10** and LINE **12.**

12
LINE. Pressing this pushbutton allows the sweep circuit to trigger on a line power supply frequency. The known power source frequency may be used as a handy reference for investigating line interference problems.

13
TV/NORM. In the NORM position (released) this pushbutton disables the TV Sync Separator circuit and the instrument operates in the normal mode. When pressed to the TV position, the TV Sync Separator is enabled and the oscilloscope triggers on the frame (100μsec or slower) or line (50μsec or faster) sync of a video signal applied to the EXT TRIGGER INPUT **17** or to a CHANNEL A **23** or CHANNEL B **29** INPUT.

14
–/+. When released, oscilloscope will trigger on positive-going edge of applied signal. When pressed, the negative-going edge will cause the trigger.

15
X–Y/SWP (sweep). Set to the SWP position (released), the oscilloscope operates in the normal mode. Set to X–Y position, the oscilloscope deflects horizontally by an amount proportional to the amplitude of the signal applied to **17**.

16
1:10/1:1. EXT TRIGGER or X-DEFL signals **17** may be attenuated by a factor of 10 when this pushbutton is in the pressed position. Release the pushbutton to return to a 1:1 amplitude ratio.

17
EXT TRIGGER/X-DEFL. For X–Y display, an external signal may be applied to this input to deflect the beam along the X-axis. Or, a desired external signal may be applied to trigger the sweep.

18
CHANNEL A POSITION. Positions trace vertically. Clockwise rotation moves the trace up and counter-clockwise rotation moves the trace down.

19
CHANNEL A VOLTS/DIV. Marked voltages on the dial of this switch show exactly what input voltage is required to deflect the beam vertically one division on the graticule when the vernier **20** is in calibrated position (full counterclockwise). For example: if you apply a 200mV amplitude signal to CHANNEL A INPUT **23** and the VOLTS/DIV switch is set to 100mV, the beam will be deflected vertically two divisions.

20
CHANNEL A (gain vernier). This control gives continuous variation within calibrated settings on control **19**, and is useful in making voltage comparisons.

21
CHANNEL A GND. When this pushbutton is pressed, CHANNEL A amplifier is grounded and any signal applied to CHANNEL A INPUT **23** is disconnected. Automatic trace is automatically applied to the CRT. This pushbutton is helpful in establishing a zero-volt level.

22
(CHANNEL A) AC/DC. Determines whether the input signal is connected to the preamplifier capacitively (AC) or directly (DC). When the signal is direct coupled, (DC), the instrument has bandwidth response from dc to 15 MHz; capacitively coupled (AC), the bandwidth response is from 2 Hz to 15 MHz.

23
(CHANNEL A) INPUT.

24–29
B channel controls. See controls 18–23.

30
VERTICAL DISPLAY. When two vertical input signals are applied (one to Channel A, one to Channel B), these pushbuttons determine which channel will be displayed on the CRT. When VERTICAL DISPLAY A is pressed, the channel A input signal is displayed, or Channel B when B is pressed. When both pushbuttons are pressed, both vertical signals are displayed at the same time. Vertical Position controls **18 29** position the displays, one above the other, to allow comparison of the two signals. Under these conditions, the signal at Channel A is internally selected as the sweep trigger. This allows the operator to compare time-lag between the two signals.

31 See Page 2–1.
Rear Panel LINE SELECT SWITCHES. These switches connect the internal power transformer to accept the primary power source voltage. BOTH SWITCHES must be set to the position marked for the power source you are using.

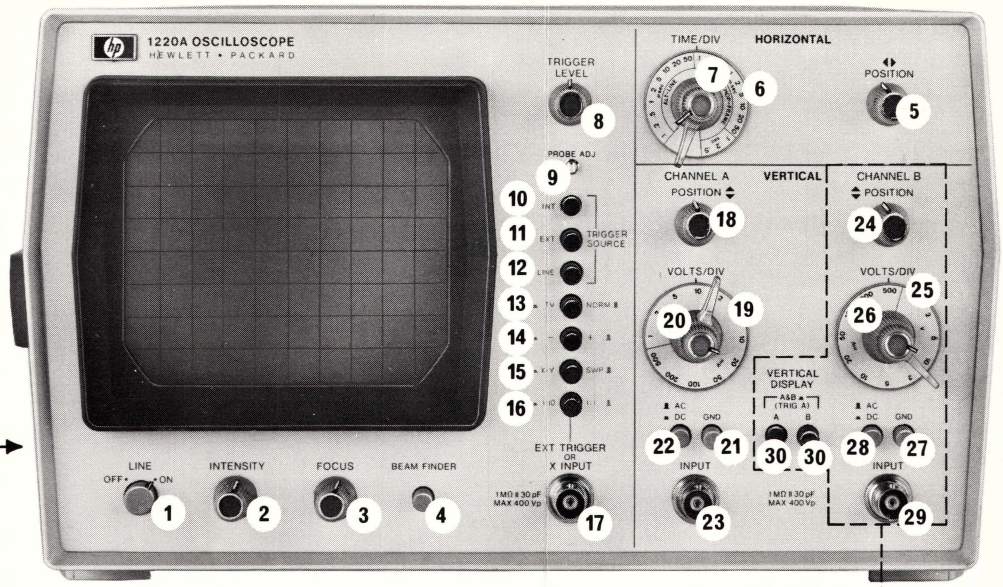
32
Rear Panel Power Receptacle. A three-prong receptacle to provide chassis ground through the power cable for operator protection.

33
Rear Panel Fuse Holder. Accepts standard fuses to provide instrument protection in case of current over-load. A 0.5Ω Ampere slow-blow fuse must be used when operating from 100V/120V power source. A 0.25 Ampere fuse is used when operating from 220V/240V power source.

34
Rear Panel Z: A banana jack that permits intensity modulation (Z-axis) voltages to be applied. A +5V signal applied to the Z input will blank a trace of any intensity. This feature is helpful in determining signal frequencies, and because it is TTL (transistor-transistor logic) compatible, computerized signals may also be used as blanking input. Maximum input at this jack is 7 Volts RMS.

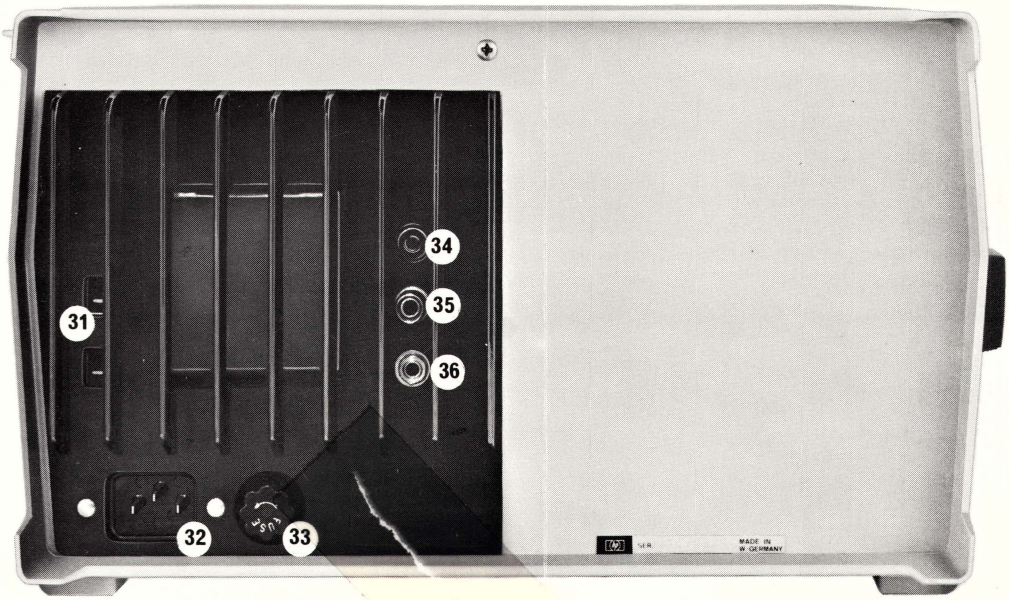
35
Rear Panel ⏚. This connector provides a convenient ground point for test instruments being used for adjustment or performance checks.

36
Rear Panel 12V.



A3R3
Trace align.

Omitted on Model 1221A



Initial Settings as above. Controls 1, 10 and 30A are pressed all other pushbuttons are released.

1
LINE. Applies primary power to the instrument.

2
INTENSITY. Controls brightness of the display.
CAUTION. a trace or spot of too high intensity may burn the phosphor inside the CRT face. See INTENSITY LIMIT adjustment in Section 3.

3
FOCUS. Controls sharpness and clarity of the display. An inter or adjustment ensures proper focus of all parts of the trace. See ASTIGMATISM adjustment in Section 3.

4
BEAM FINDER. Brings beam or trace into viewing area of CRT. When pressed, this pushbutton reduces amplifier gain to a level where trace cannot be deflected offscreen. By watching the viewing area as you press this button, you will be able to tell which other controls must be adjusted to bring the trace back on-screen i.e. POSITION controls.

5
HORIZONTAL POSITION. Adjust the movement of the trace from side to side

Figure 2–1. Controls and Connectors

2–1 GENERAL

2–2 Now that you have been introduced to your new oscilloscope, let's put it to work. First, we will tell you a few things you should do before you turn the instrument on. These things protect you and the instrument.

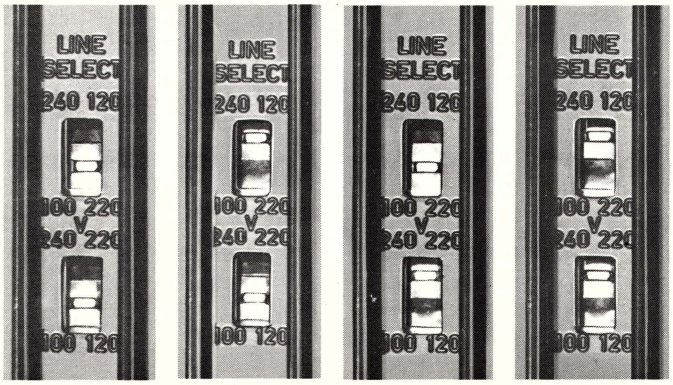
Then, we will tell you how to put the instrument into operation. Until you are completely familiar with your oscilloscope, we recommend that you perform this turn-on procedure each time you use the instrument.

Notice that in most of these procedures, we are letting the oscilloscope handle all the triggering problems. At the end of this section there is a more complete discussion of triggering information.

2–3 BEFORE INITIAL TURN-ON:

2–4 Check the fuse in the fuse-holder **33** on the rear panel. If you intend to use 100V or 120V power source, the fuse should be .5 ampere slow-blow. For a power source of 220V or 240V, the fuse should be .25 ampere slow-blow.

2–5 Check the LINE SELECTOR switches **31** on the rear panel. Correct line voltage is **very** important. If trace modulation is apparent, refer to paragraph 3–66 and table 4–2.02.



for 100V | for 120V | for 220V | for 240V

2–6 The power cord supplied with your oscilloscope is a three-wire cord with a ground terminal. Used in a power outlet with a ground terminal, the operator is protected against shock. If you are using a power outlet that does not have a ground terminal, use an appropriate adapter and fasten the ground lead to an external ground. In this way you retain the operator protection features.

2–7 INITIAL TURN-ON PROCEDURE

2–8 First, set front panel controls as indicated in figure 2–1 so that when you apply power you will achieve a display on the viewing area. Now that all the button-pushing and knob-turning is done, rotate the INTENSITY control **2** slowly clockwise, if necessary, until a trace appears on the viewing area of the CRT. If trace is not horizontal, adjust potentiometer A3 R3 (accessible through hole in side of case). Local magnetic field affects this setting. If trace modulation is apparent, check setting of the LINE SELECT switches. Set X–Y/SWEEP control **15** to X–Y and rotate the FOCUS control **3** as necessary to get the smallest, sharpest, dot . possible.

To display a full-width line, set the X–Y/SWEEP push-button **15** back to SWEEP position.

2–9 These basic control settings can be used in the following measurement procedure unless some other setting is specified.

2–10 TO DISPLAY A SIGNAL

2–11 Now that we have the instrument operating, let's apply an external signal. Once again there is some control manipulation needed to prepare the oscilloscope to respond properly and accurately.

2–12 Apply a sine wave of 10V amplitude and 1kHz frequency to CHANNEL A INPUT connector **23**. You should see a sine wave display on the viewing area approximately centered on the CRT screen. HORIZON-

TAL POSITION **5** and CHANNEL A POSITION **18** may be used to position the trace to any convenient location.

2- 13 The trace you are displaying may drift or move across the display area. This action makes accurate measurement difficult. The display can be stabilized by changing the setting of TRIGGER LEVEL control **8**.

2–14 PEAK-TO-PEAK VOLTAGE MEASUREMENTS

2- 15 Because we now have a sine wave display, this is a good place to practice making peak-to-peak measurements:

Set CHANNEL A VOLTS/DIV **19** until you have a waveform at least three divisions high. Select a TIME/DIV **6** setting that will display two or three complete cycles of the waveform.

Use the CHANNEL A POSITION control **18** to position the negative peaks of the waveform on a horizontal graticule line near the bottom of the graticule. Use the HORIZONTAL POSITION control **5** to position a positive peak of the waveform on the center vertical graticule line. Positioning the waveform this way enables you to use the small divisions on the vertical center-line more accurately.

Count the number of vertical divisions from the most negative portion of the display to the most positive portion (estimate to the nearest tenth of a division).

Multiply this number of divisions by the VOLTS/DIV control **19** setting. For example:

Number of divisions = 5.2
VOLTS/DIV setting = 0.1V
5.2 x .1 = 0.52V peak-to-peak

If you are applying the external signal through a divider probe, you must also multiply by the probe factor. For example:

Probe attenuation ratio = 10:1
Probe factor = 10

therefore, from previous paragraphs,
5.2 x .1 x 10 = 5.2 V peak-to-peak

2–16 DC VOLTAGE MEASUREMENTS

2–17 Apply the external signal to CHANNEL A INPUT **23**, press CHANNEL A GND pushbutton **21** and AC/DC button **22**. Use the CHANNEL A POSITION control **18** to locate the trace on a convenient horizontal graticule line. Reference for positive dc voltages should be below the center horizontal graticule line; reference for negative dc voltages should be above the horizontal graticule line. Do not change CHANNEL A POSITION control until measurements are complete. Release GND pushbutton **21**:

Apply the signal to be measured (square wave, pulse train, etc.) to CHANNEL A INPUT **23**.

Adjust CHANNEL A VOLTS/DIV switch **19** until the point of the signal to be measured is as many divisions as possible from the selected zero-volt reference line to make measurement easier and more accurate.

Now, use the HORIZONTAL POSITION control **5** to move the point to be measured until it rests on the center vertical graticule line.

Count the number of vertical divisions between the zero-volt reference line and the point to be measured (estimate to the nearest tenth of a division).

Multiply the number of divisions by the VOLTS/DIV setting and by the probe factor if any. For example:

Number of divisions = 6.4
VOLTS/DIV setting = .05V
Probe factor (10:1 probe) = 10
6.4 x .05V x 10V = 3.2 Volts

2–18 TIME INTERVAL MEASUREMENTS

2–19 First, display the signal as described in an earlier paragraph, and set the HORIZONTAL TIME/DIV control **6** and TRIGGER LEVEL control **8** to obtain a stable display.

Use the HORIZONTAL POSITION control **5** to position one measurement point on the signal at a vertical graticule line. Then use the CHANNEL A POSITION control **18** to position the other measurement point on the center horizontal graticule line.

Count horizontal divisions to the nearest tenth between the two measurement points. Then multiply this number of divisions by the TIME/DIV control **6** setting. For example:

Number of divisions counted = 6.4
TIME/DIV control setting = 0.5μsec
6.4 x 0.5μsec = 3.2μsec

2–20 FREQUENCY CALCULATION

2–21 Use the same procedure described for measuring the time between two points on a signal. For this calculation, use the beginning point and end point of one cycle of the signal as the measuring points.

After finding the time between these points, use this formula to calculate signal frequency:

$$\frac{1}{\text{time in seconds}}$$

Substituting numbers from the previous procedure as an example, we get the following result:

$$\frac{1}{3.2\mu\text{sec}} = \frac{1}{3.2 \times 10^{-6}\text{sec}} = 0.3125 \times 10^{6}\ \text{Hz}$$

or approximately 310kHz.

2–22 DC OFFSET MEASUREMENT

2–23 Apply signal to be measured to CHANNEL A INPUT **23**; use CHANNEL A POSITION control **18** to place negative peak of signal on the center horizontal graticule line.

Release CHANNEL A AC/DC pushbutton **22** (AC position) and note trace shift.

Count the number of divisions between center horizontal graticule line and position of negative peak of signal. Multiply this number by the CHANNEL A VOLTS/DIV setting to get DC offset voltage. For example:

Divisions of trace shift = 1.6
Setting of A VOLTS/DIV = 5mV
1.6 x 5mV = 8mV DC offset voltage

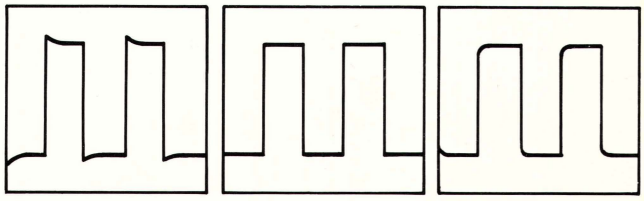
2–24 PROBE COMPENSATION

2–25 Your oscilloscope provides high input impedance and low input capacitance. These factors avoid changing the operating characteristics of the circuit you are examining. However, when a probe is used to feed signals from the circuit into the oscilloscope, the probe output must match the oscilloscope input.

2–26 A probe such as the HP Model 10013A Divider Probe provides the required compensation adjustment in the form of a screwdriver adjustment in the body of the probe. The oscilloscope PROBE ADJ **9** provides a 2kHz, .5 Volt peak-to-peak square wave output which can be used for probe compensation.

2–27 Clip the probe input to the PROBE ADJ connector **9** and attach the probe cable to the CHANNEL A INPUT **23**. Use HORIZONTAL TIME/DIV control **6** and CHANNEL A VOLTS/DIV **19** settings that will display at least two full square wave cycles large enough to read easily.

Rotate compensation adjustment on the probe body as you watch the square wave display:

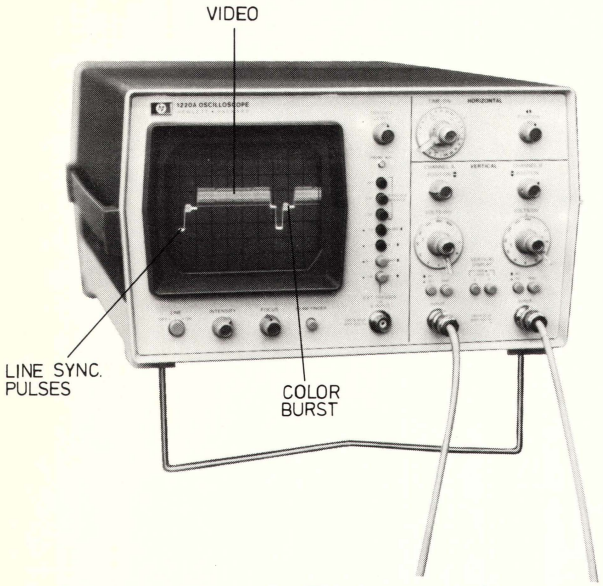


Over-compensated | Correctly adjusted | Under-compensated

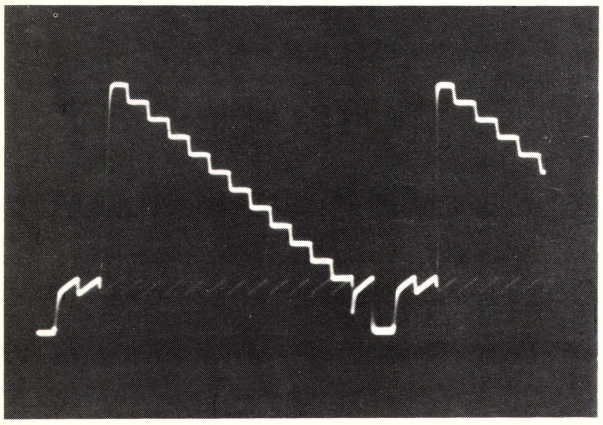
2–26 TV SIGNALS

2–29 To observe a composite or sync-only signal, apply the signal to CHANNEL A INPUT connector as described in an earlier paragraph, but change the NORM/TV pushbutton **13** to the TV setting.

If you wish to observe individual lines of picture signal, use a TIME/DIV control **6** setting in the TV LINE range (typically 2μsec), the oscilloscope will then trigger on each line sync pulse.

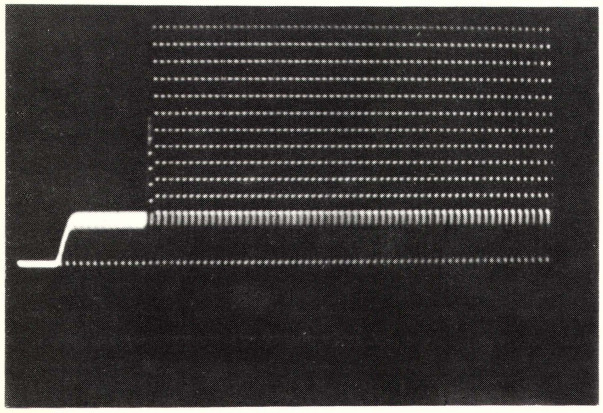


Pattern generator color TV signal, line trigger

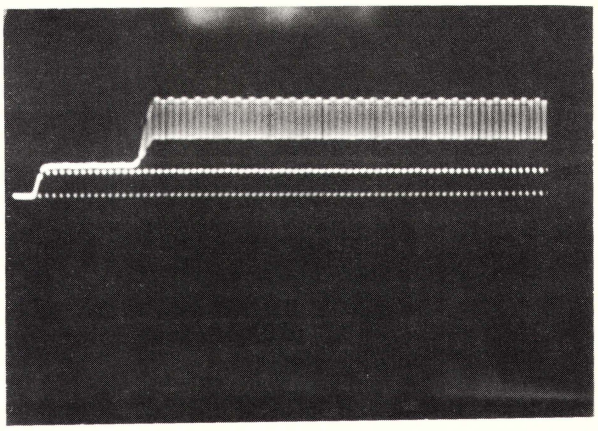


Staircase Signal, line trigger 10μs/div

To observe video field, use a TIME/DIV control **6** setting in the TV FRAME range (typically 5msec), the oscilloscope will then trigger on each frame pulse.



Color Staircase signal, frame trigger 0.5ms/div



Color bar signal frame trigger 0.5ms/div

2–30 TIME DIFFERENCE MEASUREMENTS

2–3 This description of time-difference measurements applies directly to the HP Model 1220A Oscilloscope. Measurement also applies to signals that are referenced to a common source. For example, two points in a horizontal circuit that are referenced to a common oscillator.

Display one signal on CHANNEL A INPUT **23** and the other signal on CHANNEL B INPUT **29**.

Adjust TIME/DIV control **6** so that the two points to be measured are at least four divisions apart, and readjust TRIGGER LEVEL control **8** as necessary to stabilize the display.

Use the HORIZONTAL POSITION control **5** to position the first measurement point on a convenient vertical graticule line. Then use the appropriate VERTICAL POSITION control **18 / 24** to position the second measurement point on the center horizontal graticule line.

Count the horizontal divisions between the two measurement points (to the nearest tenth of a division) and multiply this number by the TIME/DIV switch setting. For example:

Number of divisions = 6.5
TIME/DIV setting = 5msec
6.5 x 5msec = 32.5msec = time between points.

2–32 PHASE DIFFERENCE MEASUREMENTS

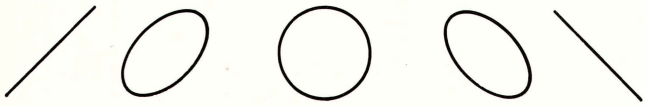
2–33 Phase difference measurements can be made between two signals of the same frequency by applying one signal to the vertical deflection amplifier and the other to the horizontal amplifier. Start by making the following control settings:

X–Y/SWEEP **15** to X–Y position
CHANNEL AC/DC **22** to AC position
VERTICAL DISPLAY **30** to A only

Now, apply the first signal to CHANNEL A INPUT **23** and by using CHANNEL A VOLTS/DIV **19**, POSITION **18**, and vernier **20**, obtain two dots separated by exactly **8** vertical divisions. Use HORIZONTAL POSITION **5** to set these dots on the center vertical graticule line, and press CHANNEL A GND **21** to remove the channel A display while you set up the horizontal display.

Apply the second signal to the X INPUT connector **19**. Now use EXPANDER **7** and CHANNEL A POSITION **18** to display two dots **8** divisions apart on the center horizontal graticule line.

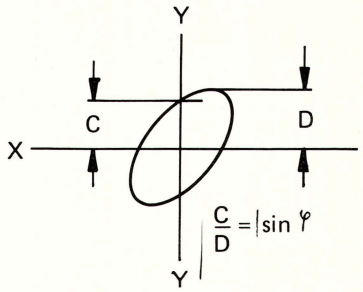
Release the CHANNEL A GND pushbutton **21** and observe the display on the CRT. The following sketch indicates a few possibilities:



Phase difference	0°	45°	90°	135°	180°
Figure	A	B	C	D	E

2–34 An ellipse formed between 0^{o} and 45^{o}C will slant in the same direction as figure B, but will have a narrower opening. An ellipse formed between 45^{o} and 90^{o} will have the same slant, but a larger opening.

Determining the actual phase relationship involves some further calculation that looks more complex than it really is. Move the ellipse until it is centered at the intersection of the center vertical and horizontal graticule lines. Measure the distances C and D as shown below and substitute these distances in the formular given to obtain the sine of the phase angle. Look up this sine in a table of sines to find the phase angle. If the ellipse indicates an angle between 90^{o} and 180^{o}, calculate the sine as described above and subtract the resulting angle from 180^{o} to obtain the true value.



2–35 TRIGGERED SWEEP SUMMARY

2–36 Older oscilloscopes had a free-running sawtooth sweep ramp generator. This sawtooth ramp deflected the applied signals at a set speed across the face of the CRT, but there was no adequate control over blanking during retrace, and the applied signal would start at some random point for each trace.

2–37 The HP Model 1220A/1221A Oscilloscopes have what is called Triggered Sweep. Basically, this means that no sawtooth ramp voltage is generated in the horizontal sweep circuit until a vertical input signal is applied. Other refinements have been added, too.

2–38 What advantages do you derive from this type of operation?

The CRT screen does not show a spot while waiting for the next vertical pulse to be applied

Through the use of the associated TRIGGER LEVEL control **8**, you can trigger the sweep at any point.

No portion of the retrace signal is visible on the CRT to cause confusion at a critical point in measurement. This is accomplished by having the ramp generator apply a blanking signal to the horizontal output at the same time that retrace is started. As soon as retrace is complete, the blanking signal is removed.

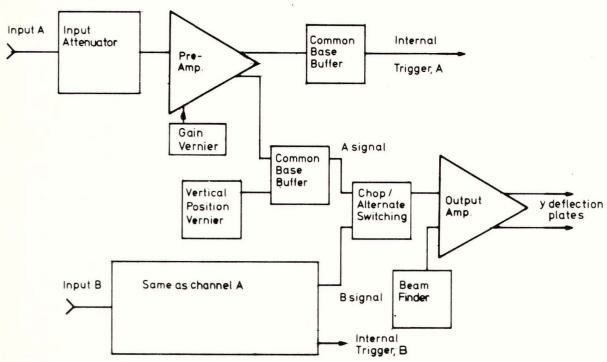
Very slow sweep speeds are obtainable without using any external components to modify the sweep oscillator and ramp generator. The HP Model 1220A/1221A Oscilloscopes are capable of sweeps as slow as 0.5 seconds per division.

When no vertical signal is applied, the instrument automatically displays a bright line continuous trace. This capability can be of great help in setting up a zero-volt reference line for measurement purposes.

2–39 TV Sync Separator as Low Pass Filter

2–40 If triggering from noisy or complex source, the TV sync separator can be used to reject components above 20kHz.

3–1 VERTICAL CHANNEL(S) (Figure 5–3)



3–2 Input Attenuator

3–3 The input attenuator divides the input signal by 1, 10 or 100.

3–4 Preamplifier

3–5 The preamplifier is a 3 stage differential amplifier with switched gain control and input protection. CR101 and CR102 limit excessive signal swings from the input attenuator to ± 4.1V (approx.) as defined by zener diodes CR104 and CR105. The signal is applied to the first differential amplifier stage (U101b, U101d) via a source follower (Q101a) and emitter follower (U101c).

3–6 Ranging is achieved, in conjunction with the input attenuator, by selecting different emitter current paths in the first and third preamplifier stages. In the first stage this is effected by the differential switch, Q103/Q104, under control of the VOLTS/DIV switch. In the 2mV, 5mV and 10mV positions the switch connects the potential from the junction of R182/R183 to the base of Q104. Q103 cuts off causing Q104 to route the emitter current via R125 and R126. In the other positions (above 10mV) Q103 conducting draws the emitter current via R123 and R124. In this case the amplification is one tenth (1/10) of that selected in the 2mV, 5mV and 10mV positions. In the last preamplifier stage, gain is controlled in precisely the same manner by U 102b, (X1), U102a (X2) and U102e (X5). Fine control is achieved by VERNIER R149 in the second preamplifier stage while overall gain of the complete Y channel is adjusted by R162 (when the fine VERNIER is in the CAL Position). Balance potentiometers R114, R148 and R175 are adjusted so that the trace does not move when switching from one range to another.

3–7 Common Base Stages (Q110)

3–8 For internal triggering purposes, one output of the preamplifier is buffered to the trigger circuits by common base stage Q110. The other output is buffered to the chopper circuit via common base stage Q109. At this stage the signal is offset by a current derived from the vertical position vernier (R159).

3–9 Chopper

3–10 The chopper circuit (CR301–CR304) is controlled by the Chop-Alt Control Flip-Flop. During Channel A operation CR303 conducts causing CR304 to cut off and block the channel B signal. At the same time CR301 is cut off enabling CR302 to pass the channel A signal to the output amplifier. During Channel B operation the situation is reversed so that only Channel B signal is displayed.

3–11 When both channels are to be displayed in the chopped mode of operation (when Time/Div switch is in 1ms to 0.5s range) the chopper circuit switches between channels A and B so that both channels are displayed during the same sweep. When both channels are to be displayed in the alternate sweep mode (.5ms to .1μs) the chopper circuit alternately selects channel A on one sweep and channel B on the next.

3–12 Output Amplifier

3–13 The signal from the chopper circuit is applied to the current amplifier Q301/Q302 which in turn drives the Vertical Output Amplifier. The output amplifier comprises a differential input stage which drives two identical negative feedback amplifiers.

3–14 The differential input stage comprises U301a, U301b, U301c and U301d. U301a and U301b are connected as back-to-back diodes (joined at the cathodes) and linearize the essentially logarithmic characteristic of the differential amplifier at high signal levels. At low signal levels the characteristics requires no linearization.

3–15 Diodes CR305 and CR306 prevent the amplifier from going into saturation when excessive signals are applied or when the vertical position vernier is at one of its extremes.

3–16 The BEAM FINDER switch, when pressed, disconnects R312 from the emitter circuit of the differential input stage. This reduces the overall gain of the output stage (and consequently reduces the deflection) so that the trace is always displayed regardless of the position of the vertical position vernier. This does not affect the intensity.

3–17 The final output comprises two identical amplifier stages. For convenience only the left hand channel (Q411, Q409, Q407, Q405, Q403 and Q401) is described. Q407 and Q405 form a cascode amplifier with negative feedback supplied to driver stage Q409/Q411 through R416 and R418. Q401 and Q403, connected in series comprise a driven (by C405) current source. The steady state current level is established by R401 while extra current needed by fast transients is supplied by C401. High frequency components of the deflection signal are coupled to the current source via C405.

3–18 HORIZONTAL CHANNEL

3–19 There are two basic modes of operation of the horizontal deflection circuits,

as an amplifier (in the X–Y mode)
or,

as a synchronous reference source for the horizontal axis of the display.

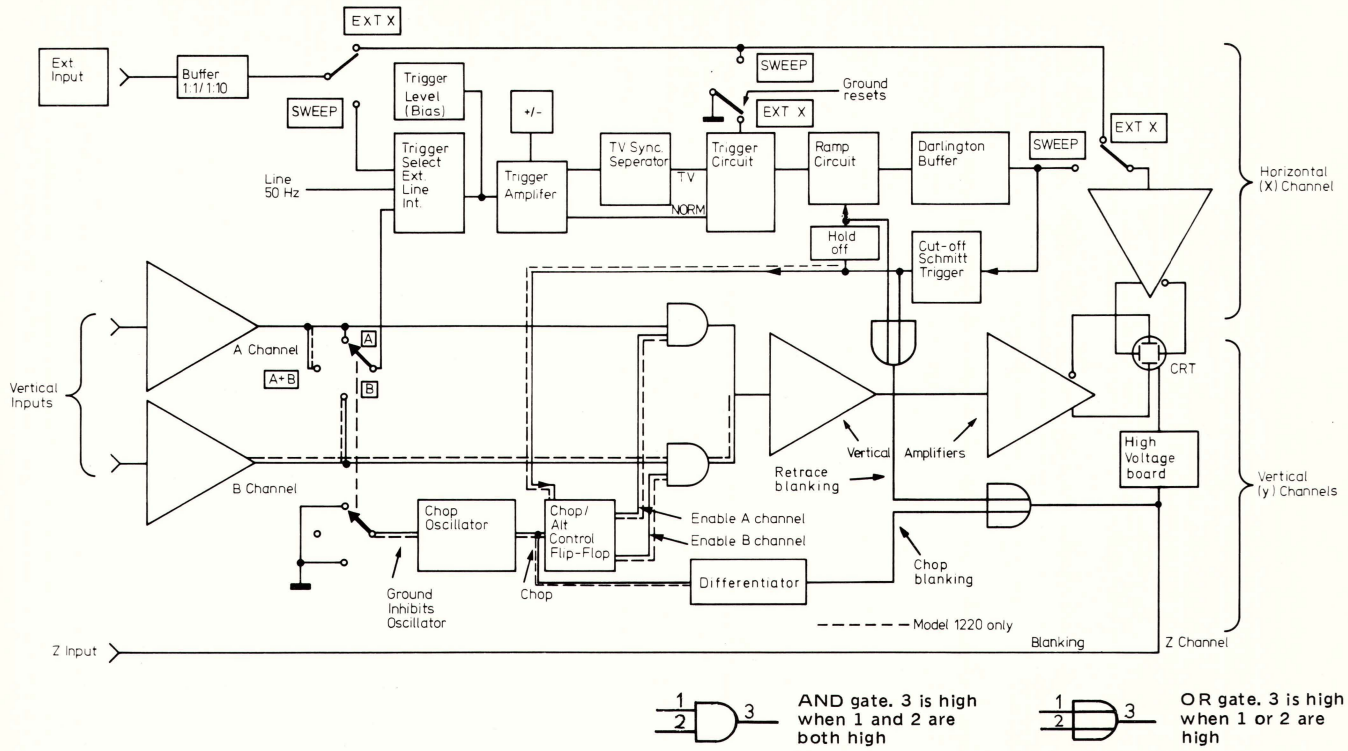
In the EXT DEFL mode, the external input is applied to the horizontal Output Amplifier via the Ext Input Buffer. The rest of the circuitry is disabled.

3–20 When used as a synchronous, time related, horizontal reference source, the horizontal deflection circuit requires a trigger signal. The Trigger Selector Switches select the source of the trigger signal from either the Ext Input (EXT mode), the power supply (LINE trigger) or from the A or B channel preamplifiers (INT mode). The trigger signal is then summed with the output of the trigger LEVEL vernier and applied to the Trigger Amplifier so that triggering occurs when the trigger signal passes the threshold of the Trigger Circuit. By shifting the signal with the LEVEL vernier, the point, on the trigger signal waveform, at which triggering is to occur can be varied.

The +/– switch applies the trigger signal to either the non-inverting or inverting input of the Trigger Amplifier, so that the slope (positive or negative), on which triggering is to occur, can be defined.

Alternatively, in the TV mode, the output from the Trigger Amplifier is applied to the TV Sync Separator. This circuit separates Field and Line sync pulses from a composite video signal and, depending on the sweep speed selected, applies either Frame (Field Rate) or Line sync pulses to the Trigger Circuit.

3–21 On receipt of a signal from the sync separator or the Trigger Amplifier, the Trigger Circuit enables the Ramp Generator and causes the Blanking Circuit to remove the blanking signal so that a trace is displayed. The ramp is applied simultaneously to the horizontal Amplifier and the Cut-Off Schmitt Trigger (C.O.S.T.) via the Sweep Output Buffer. The Sweep Length Adjust vernier attenuates the ramp. When the attenuated ramp reaches the threshold of the C.O.S.T., the C.O.S.T. resets the Trigger Circuit and starts the Hold-Off circuit. Resetting the Trigger Circuit disables the Ramp Generator which causes the C.O.S.T. to be reset. However, because the Ramp Generator takes a finite time (proportional to the ramp time) to be completely reset, the Hold-Off circuit keeps the Trigger Circuit reset until the Ramp Generator is completely reset. This prevents premature starting of a new ramp by another trigger signal. If, by 500ms after the last trigger was received, no new trigger signal occurs the Trigger Circuit automatically starts a new ramp so that a trace is still generated.



1 2 3 AND gate. 3 is high when 1 and 2 are both high

1 2 3 OR gate. 3 is high when 1 or 2 are high

3–22 When both channels A and B are to be displayed simultaneously, the sweep speed determines which method of display (chop or alternate) is to be used. At sweep speeds of 0.5ms and faster, A and B are displayed on alternate sweeps. This is achieved by the Chop-Alt Control Flip-Flop being clocked after every sweep by the C.O.S.T. Thus, during one sweep, channel A signal passes through the switch and, during the next sweep, channel B signal passes. At sweep speeds of 1ms and longer, the Chop Oscillator drives the Chop-Alt Control Flip-Flop (at approx. 200kHz) so that during each sweep both signals are passed by the Chopper at alternate 5μs intervals. During single trace operation the Chop-Alt Control Flip-Flop is held in the Preset (A displayed) or Clear (B displayed) state by the A B display switches.

3–23 Detailed Description (figure 5–4)

3–24 Ext Input Buffer

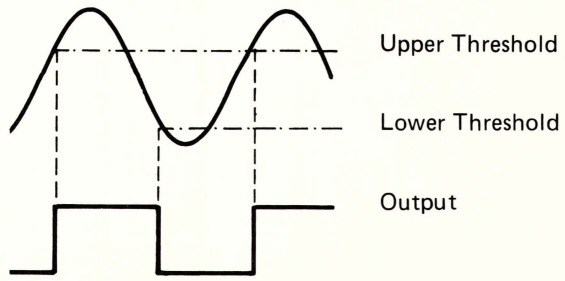
3–25 The buffer comprises source follower Q1, which provides high input impedances, and emitter follower Q2, which provides low output impedance for driving the horizontal amplifier or trigger amplifier.

3–26 Trigger Switches

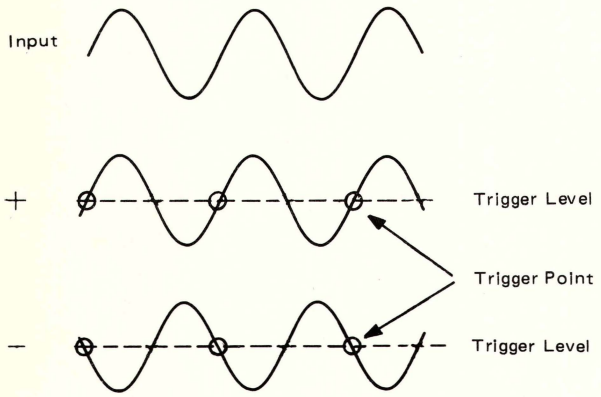
3–27 The trigger switches select the source of the trigger signal. When EXT (external trigger) is selected, the signal from the Ext Input Buffer is applied to the Trigger Amplifier. When LINE trigger is selected, the switch connects the line frequency signal (from the +5V secondary winding of the power supply) to the Trigger Amplifier. When LINE is not selected (i.e. when another trigger mode is selected) the line frequency signal is grounded, via R1, so that it cannot be a source of a line frequency interference. Similarly, when EXT triggering (triggering from the signal of either channel A or B) is not selected, the signal from the EXT INPUT BUFFER is grounded through R10.

3–28 Trigger Amplifier

3–29 The trigger signal is ac coupled, via C27, to the trigger amplifier which comprises Q3, Q4, Q5, Q6 and Q7. At the input, the signal is offset by the TRIGGER LEVEL vernier (R20) so that the output signal is shifted relative to the threshold level of the Input Schmitt Trigger MC7a in the Trigger Circuit. This permits the Schmitt Trigger to be triggered from various amplitude levels of the trigger input signal:



While this defines the trigger level, the +/– switch of S2 selects the input (inverting via Q6 or non-inverting via Q3) to which the signal is applied so that the slope on which the threshold level is relevant can be defined. The two controls define precise points on the trigger waveform.



R66 is a symmetry control which is adjusted so that the dc level of the output of the amplifier is the same for inverting and non-inverting operation.

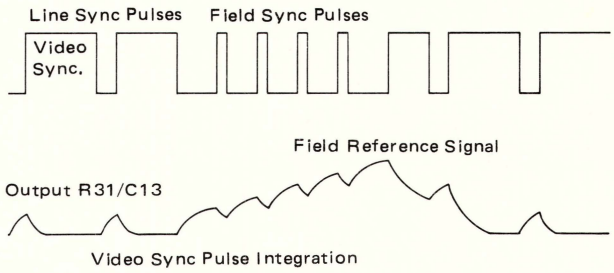
3–30 When the TV/NORM switch is in the TV position, the trigger signal is taken from Q4 collector and applied to the TV Sync Separator. Q7 is cut off to prevent the (unprocessed video) signal from reaching the Trigger Circuit and to enable the Trigger Circuit.

3–31 TV Sync Separator

3–32 The sync separator separates the Field and Line sync pulses of a composite video signal and outputs either Line sync pulses or the Frame (Field Rate) signal to the Trigger circuit.

C11 and R29 filter the video portion of the signal to produce a mean dc level. Thus, when a sync pulse occurs it is superimposed on this dc level and turns on Q8 so that only sync pulses reach the sync separator.

When the sweep speed is set in the range 0.1μs to 50μs/div, Flip-Flop MC8 is held in the Preset state and only the Line Circuit provides an output. In the Line Circuit Q10, MC2b and R37 are connected as a Schmitt trigger so that sync pulses are only re-shaped. When the sweep speed is set to sweeps longer that 0.1ms/div the 0V is removed from the Preset input of MC8b and the Frame circuit is enabled. This signal is integrated by R31/C13 and applied to Clock Input of MC8b via the Schmitt Trigger comprising Q9/MC2a and R33.



Only when the field sync pulses occur does the Integrator output reach a level sufficient to clock MC8b. Because MC8b divides the Field sync pulses by a factor of 2, triggering occurs on alternate field sync pulses. When Frame circuit operation is selected, the LINE circuit output is always high (+5V) so that MC4a is enabled and inverts the Frame signal from MC8b. In the Line mode MC8b in the preset state (Q output High) enables MC4a so that the line sync pulses are inverted by MC4a.

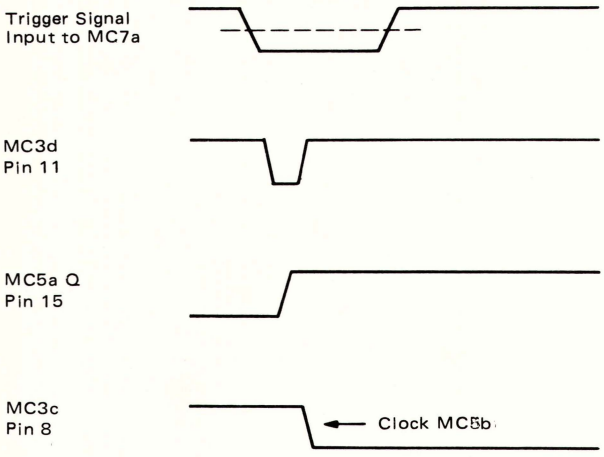
3–33 Trigger Circuit

3–34 On a negative transition from either the Trigger Amplifier or the Sync Separator, Input Schmitt Trigger MC7a output (pin 6) goes high. This is immediately present at MC3 pin 13 causing MC3 pin 11 to go low. (Because MC13 pin 12 is, at this moment, still high due to the propagation delay of MC1 a, b, c). The low-to-high transistion from MC7a pin 6:

Clocks MC5A (Q goes high and enables MC3c).

Clocks MC6a (this enables MC2d and hence MC7a hold-off).

After the propagation delay times of MC1a, MC1b and MC1c, a high-to-low transition occurs at MC1c pin 6 causing MC3d pin 11 to go high. This positive transition is inverted by MC3c (enabled by MC5a Q output) to clock MC5b so that MC5b Q output goes high and Q goes low. MC5b Q output low enables the Ramp Generator and causes the blanking circuits to remove the blanking signal MC5b Q output high causes a low at MC2d pin 11 (MC2d enabled by Q output of MC6) which holds off the input Schmitt trigger MC7a.



3–35 Ramp Generator

3–36 The ramp generator comprises a constant current source (Q11, CR6 to CR7, R42 and one of R88 to R95) which charges a selected capacitor (C28 and C29 or C30, C31 or C32). The output voltage increases linearly with time at a rate proportional to the value of the capacitor and the charging current. The circuit is controlled by Q12 which is in turn controlled by the Trigger Circuit. When Q12 is conducting (between sweep) the selected capacitor is discharged and the current from the current source flows to ground through Q12. When Q12 is cut off (during sweep) the current source charges the selected capacitor.

3–37 When the ramp is completed a negative transition from the Cut-Off Schmitt Trigger MC7b clears MC5b so that the Ramp Generator is disabled and the hold-down at the input of the input Schmitt Trigger MC7a is removed. However, to prevent premature triggering, the Hold-Off circuit keeps MC5a and MC5b in the clear state (pins 3 & 8 low) until the Ramp Generator is fully reset. When the Hold-Off signal is removed the next trigger can restart the sequence. If no trigger is received within 500ms (approx.) of the last trigger, the Bright Line Auto monostable MC6 returns to its stable state (Q output low, $\overline{Q}$ output high) and sets MC5b to its preset (Q high, $\overline{Q}$ low) via MC3a. Thus, the Ramp Generator is enabled and a sweep occurs although it is asynchronous. At the end of this sweep, if no new trigger has been received then the end of Hold-Off presets MC5b so that another sweep is started. Thus, until MC6 is set to its quasi-stable state by a new trigger, continuous sweeps occur with minimum time between them. In the normal mode of operation (i.e. when trigger pulses are applied), MC6 is always in its quasi-stable state because it is a retriggerable mono-stable.

3–38 Sweep Output

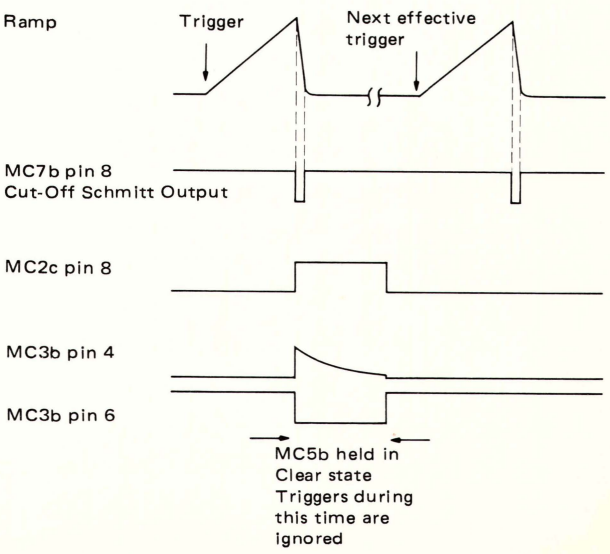
3–39 The sweep output circuit comprises Q13 and Q14 connected as a Darlington pair to provide high input impedance, low output impedance and high current gain. The Sweep Output Circuit buffers the ramp to the Horizontal Output Amplifier and the Sweep Length Adjust vernier.

3–40 Sweep Length Adjust

3–41 When the ramp signal at MC7b pin 9 reaches the threshold level of the Cut-Off Schmitt Trigger, MC7b switches so that the Trigger Circuit is reset and the Hold Off circuit is enabled. The point in time (and hence the length of the sweep) at which the threshold level is reached is adjusted by R98.

3–42 Hold-Off Circuit

3–43 The Hold-Off circuit is a monostable which holds the Trigger Circuit off while the ramp generator capacitor is discharged. This is to prevent premature starting of a sweep. The monostable consists of MC2c, either C33, C34, C35 or C36, R46 and MC3b. When the output of the cut-off Schmitt Trigger goes low, MC2c output goes high. The loop MC2c/MC3b retains this status for an interval so that MC5b is held in the clear state. This interval permits complete discharge of the ramp capacitor.



3–44 Horizontal Output Amplifier

3–45 The horizontal output amplifier is very similar to the vertical deflection amplifier. The differential input stage Q15 and Q16 provides gain adjustment and horizontal position control (R105). When Beam Find is pressed the gain of the amplifier is reduced (because of R64) so that the sweep is shortened and can also always be seen on the display regardless of the position of the horizontal position vernier R105. The output stage comprises two identical channels as in the vertical deflection section.

3–46 Chop Oscillator

3–47 The chop oscillator comprises MC4b and MC4c connected as a free running multivibrator. The oscillator, which runs at approximately 200kHz is disabled in the single channel display mode and at sweep speeds faster than 0.1ms/div. The oscillator is also disabled between sweeps (by Q output of MC5b).

3–48 Chop-Alt Control Flip-Flop

3–49 In the chop mode (sweep speeds of 1ms and longer) with dual trace operation selected, the Chop-Alt Control Flip-Flop (MC8a) is clocked by the Chop Oscillator via MC4d. In the Alternate mode (sweep speeds of 0.5ms and faster) with dual trace operation selected, the Chop-Alt Control Flip-Flop is clocked at the end of each sweep by the signal from the Cut-Off Schmitt Trigger.

In single trace modes, the Flip-Flop is held in either the Preset (Channel A display) or the Clear (Channel B display) state.

3–50 Blanking

3–51 The purpose of the blanking circuit is:
to suppress retrace,
to suppress trace during switching in chop operation,
to provide a Z-input
(for trace modulation e.g. time markers).

Retrace is suppressed by the Q output of MC5b (which goes low at end of each sweep) via CR16 and MC4d. The connection via CR5 direct to the C.O.S.T. ensures that blanking takes place immediately sweep ends.

In chop operation, the differentiated chop oscillator signal (C45, R96, R99), provides blanking during switching from one channel to the other.

Z input and the output of MC4d are fed over similar shaping networks to the blanking amplifier on A3.

3–52 Blanking Amplifier (figure 5–2)

3–53 The blanking amplifier Q2/Q4 is an inverting amplifier which drives the grid of the CRT, via C6, to cut off the electron beam during trace return (between sweeps), during chop mode operation (between chops) and under control of the Z axis input. Q2 acts as a current source load at low frequencies and as an active "pull-up" at high frequencies. Commutating capacitor C8 and decoupling capacitor C7 improve the high frequency response. CR18 and CR1 clamp the output at approximately 32V when no blanking signal is present. C6 differentiates the blanking pulse and isolates the amplifier from the high grid voltage.

3–54 Power Supplies (figure 5–2)

3–55 +5V Supply

3–56 The output of the 12V ac secondary of T1 is rectified by bridge rectifier CR13–CR16 and regulated by MC3.

3–57 +210V Supply

3–58 The +210V supply is an unregulated 115V supply which is offset by 95V at the junction of CR3/CR4 of bridge rectifier CR1–CR4.

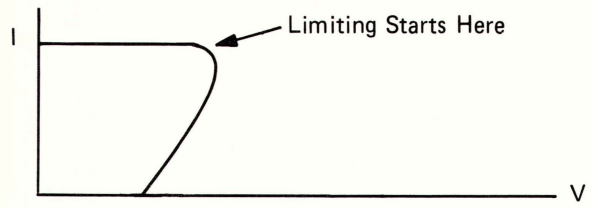
3–59 +95V Supply

3–60 The +95V supply is a fully regulated, current limiting supply. A sample of the output voltage (at pin 4 of MC1) is compared with a reference voltage (at pin 5 of MC1). A difference between these two potentials causes an error output from pin 9 of MC1 which controls series regulator transistor Q1. When the output voltage falls the error voltage causes Q1 to conduct more and supply more current to the load with a consequent increase in output voltage.

When the output voltage rises the error signal tends to cut off Q1 to reduce the output current and effect a lowering of the output voltage.

Current limiting is achieved by R4 and a cut-off transistor in MC1. As the current output increases, the voltage dropped across R4 increases. Pins 2 and 3 of MC1 are the base and emitter connections (respectively) of the cut-off transistor.

When the potential dropped across R4 is sufficient to cause this transistor to conduct, it removes the error signal from Q1 causing the output current to fall. R5 and R6, in conjunction with R4, give a "foldback" characteristic to the supply. That is, when the current limit is reached the output voltage also falls to a low value (see characteristic).



Foldback Current Limiting

3–61 +12V Supply

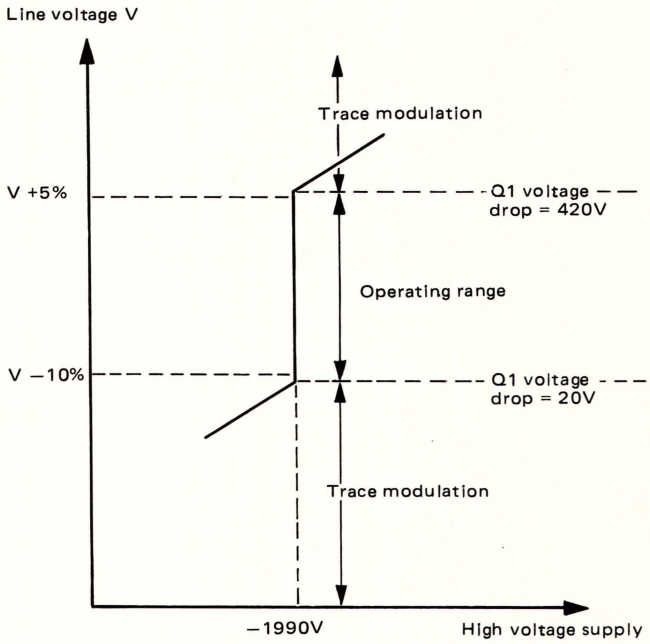
3–62 The +12V supply is also a series regulated, current limited supply which operates in similar fashion to the +95V supply. The reference voltage, with which the output sample is compared, is derived from the +95V supply.

3–63 –12V Supply

3–64 The –12V supply is also a series regulated, current protected supply. However, the sample of the output voltage is derived from both the +12V and –12V output, so that the difference between the +12V and –12V supply is always constant. When current through R20 causes a voltage drop across it, sufficient to turn-on Q4, Q4 takes all the current from MC4 causing the output current to fall.

3–65 High Voltage Supply

3–66 The voltage from the 1600V secondary of T1 is rectified (CR14–17), applied across capacitor A3C1 regulated by A3Q1, applied to the intensity network and the CRT heater. To regulate, a portion of the H.V. supply is compared with the +95V supply. The resulting A3MC1 output controls the emitter/collector resistance of A3Q1 so that the voltage dropped across the transistor compensates for high voltage supply fluctuations. A zener diode chain is connected across collector and emitter so that the transistor's breakdown potential is not reached. The characteristic of this arrangement is :



The horizontal position of the characteristic, and consequently the level of the high voltage supply, is adjusted by R30. The vertical position is set by R1 so that proper regulation occurs in the range +5% , –10% of the selected line voltage. If the line voltage goes outside this range, regulation will cease and ripple – causing trace modulation – will be apparent. Consequently, in districts where the line voltage excursions lie outside one of the regulator limits, R1 should be adjusted so that the characteristic brackets these excursions rather than the nominal 110, 120, 220 or 240 volts, +5% , –10% .

3–67 Probe Adjust Supply (figure 5–4)

3–68 MC1d and MC1e operate as a free running multivibrator the output of which is buffered to Probe Adjust Connector via MC1f.

SECTION 4

MAINTENANCE

4–1 PREVENTIVE MAINTENANCE

4–2 If carried out regularly (quarterly or half-yearly), the short time spent on preventive maintenance will be adequately repaid because the inherent reliability and accuracy of the oscilloscope will be maximized.

4–3 Mechanical Inspection

4–4 Check that all fittings, connectors and boards are firmly in place. Check that wiring and cables – especially these of power supply and high voltage – are in good condition.

4–5 Ensure CRT socket is fitted firmly. Make sure that the securing screws of the heat sink assembly are tight so that there is good thermal contact between heatsink and power transistors, verify that electrical insulating sheet (with silicone grease) is between transistor and heatsink.

WARNING
VOLTAGES DANGEROUS TO LIFE

High voltages are used in this instrument. Switch off, disconnect from supply and wait for a few minutes before removing covers.

4–6 Lubrication and Cleaning

4–7 Remove dust from interior. If rotary switches become noisy, clean with aerosol degreaser (part number 8500–0232), allow to dry, then lubricate with Elektrolube 2A aerosol spray (part number 6040–0300). Avoid cleaners with a grease or oil content.

4–8 Adjustment

4–9 Perform the adjustment procedure (table 4–2).

WARNING
VOLTAGES DANGEROUS TO LIFE

Exercise caution when operating the oscilloscope without covers.

4–10 Performance Check

4–11 Carry out the performance checks in tables 4–3.

4–12 TEST INSTRUMENTS

4–13 Refer to table 4–1.

4–14 SERVICING

4–15 When a fault is evident it is necessary to localize the cause (see below), effect the repair (see 'Removal of assemblies' and 'Repairing circuit boards', readjust (table 4–2) and to verify performance (table 4–3). The following paragraphs outline a possible approach to troubleshooting using a minimum of test equipment.

4–16 TROUBLESHOOTING

Before commencing troubleshooting, make sure that an apparent fault is not caused by incorrect supply, fuses or control settings. In the following paragraphs, reference should be made to the circuit diagrams (Section 5) and the voltages and waveforms thereon.

4–17 Low Voltage Power Supply

NOTE

All low-voltage power supplies contain short-protection circuits. If any supply shows an unusually low voltage reading it may indicate a short in any circuit using that supply.

4–18 +95V Supply

4–19 Measure +95 volt output test point. If this voltage is wrong, check rectifier output voltage. If rectifier output is wrong, suspect rectifier transformer winding, or bad A2C3/R13.

Measure voltage to pin 11 of A2MC1 to be sure it is 20V higher than voltage at A2 +95V Test Point. If it is not, suspect A2CR21 or 210V supply. Measure voltage at base of A1Q1; it should be more positive than emitter voltage (up to 0.6V). If not, and voltage at pin 11 MC1 is right, check components in voltage divider A2R7/R8/R9/R10/R11. If these are ok, trouble is in A1MC1 or A2Q1.

4–20 +12V Supply

4–21 If voltage at A2 +12V test point is wrong, check output of +12V supply rectifier. If rectifier output satisfactory, check voltages at A2MC2 pin 3. If wrong, check +95V input and components associated with A2MC2 pin 3.

If voltage at A2MC2 pin 3 is satisfactory, check voltage at the base of of A2Q2. If it is not more positive than the emitter voltage, either A2MC2 or R17/R27 may be faulty.

4–22 –12V Supply

4–23 Measure voltage on one side of rectifier output, then the other side. Note this voltage difference to be more than 16 volts. Check accuracy of voltage at Pin 3 MC4 voltage divider.

If these are in order, check A2Q3/Q4. If satisfactory, replace A2MC4.

4–24 +210V Supply

4–25 If rectifier output and +95 volt supply are correct, check components A2R1, R2, R3, etc. and load.

4–26 +5V Supply

4–27 If rectifier output is correct, check A2MC3, C9, C10 and load.

4–28 High Voltage Power Supply

WARNING

Voltages in this circuit are dangerous to life. Use extreme caution. Remove shield only to gain access. Replace shield immediately afterwards.

4–29 Circuit theory will be your best guide in checking this circuit. See paragraph 3–65.

An indication of too high a voltage at A2TP1 (+450V or higher) and a low voltage at A3TP2 (–1700 to –1900V) can be due to an open High Voltage Regulator, A3Q1. To check this possibility, measure the voltage at the junction of MC1 pin 6. If the voltage reading is not +0.8V or greater, there is likelihood of a fault in the voltage regulator MC1 or A3R11/R12/R13/R14/R15/R17/R18/R4/CR12.

The Trace Align circuit is straight forward. If the power supplies and potentiometer A3R3 are in order, there is trouble in the Trace Align coil on the neck of the CRT.

Astigmatism failure is equally easy to check. If the power supply to A3R2 is ok and A3C9 is good, trouble in the CRT may be assumed after checking the CRT socket connections (CAUTION!).

4–30 Vertical Amplifier Circuits

4–31 Troubleshooting the Vertical Amplifier Circuits starts by attempting to localize the trouble into the Attenuator, Preamplifier Circuits or Output Amplifier Circuit. A few simple front panel control operations may help.

4–32 Turn the instrument on and display a trace or spot. Make these checks on both channels of Model 1220A:

Does the vertical POSITION control **18, 24** move the trace outside the viewing area both top and bottom? If only one trace POSITION control is working correctly, probably the other channel preamplifier is wrong. If neither channel is working correctly, the output amplifier is probably wrong.

Position the trace or dot on a convenient horizontal line. If display shifts up or down, when VOLTS/DIV switch **19** is rotated, the preamplifiers are not symmetrical.

Using a 10:1 divider probe to apply PROBE ADJ signal **9** to CHANNEL A INPUT **23**, can the square wave be compensated by the probe? If it can, the attenuator is probably correctly compensated.

4–33 If any of these checks give a fault indication, there is either a problem of unbalanced amplifiers or a faulty circuit. Check first to be sure that A2 board 12V supplies are in order.

4–34 To eliminate the possibility of an unbalanced condition, or wrong gain we recommend that you perform the Calibration Adjustment procedures for the vertical and attenuator circuits. This may eliminate extensive troubleshooting.

4–35 If, after completing the adjustment procedures, the problem still exists, determine which vertical circuit is causing the trouble (if, in Model 1220A, both channels are faulty, fault must lie in common parts) and verify the voltages at test point A2TP1, at the output of the X1, X10 Preamplifier (TP3 in Model 1220A), and A2TP2 at the output of X1, X2, X5 Preamplifier. Noise may be caused if ground bonding screw (paragraph 4–74) is loose.

4–36 To Troubleshoot with a Monitor Oscilloscope

4–37 Initial settings (fig. 2–1) except:

6 to 0.2 msec/div
19 to 100 mV/div
22 to AC

Apply PROBE ADJ. **9** signal direct to INPUT **23**.

Set monitor oscilloscope with same control settings except 20mV/div on the VOLTS/DIV switch. Use a 10:1 divider probe to monitor the output at A2TP1 (A2TP3 for Channel B in Model 1220A).

4–38 The monitored waveform should be a square wave of approximately 1.7 vertical divisions peak-to-peak. If it is, you may assume the Attenuator and X1, X10 Preamplifier are working as they should.

4–39 To eliminate Attenuator or Preamplifier, leave all control settings the same and monitor the output at A2TP2. The waveform should be a square wave of approximately 2.8 vertical divisions peak-to-peak. If the waveform is incorrect, troubleshoot the X1, X2, X5 Preamplifier (or the Chop-Alt Control on board A3 in Model 1220A.)

4–40 To Troubleshoot with a Voltmeter

4–41 A look at the A2 Amplifier Board schematic shows that each section is a symmetrical amplifier. It also shows voltages at certain representative points in each section. These voltages are measured with no input to the instrument, with the appropriate VOLTS/DIV switch set to 100mV position, and with CHANNEL A (or B) GND pushbutton **21/27** pressed to avoid transient input.

4–42 Check these representative voltages in your instrument as shown on the schematic. Other voltages at unmarked corresponding points in the circuit should be symmetrical whatever the value. For example, the voltage you measure at the emitters of A2Q103/Q104 should be –6.5 V; the voltages at pin 2 and pin 12 of A2U101 should be symmetrical whatever the value.

4–43 When a point is found where voltages are incorrect or unsymmetrical, this is a point where you can begin looking for components that have changed value, transistors that are leaky or breaking down, diodes that are faulty, etc.

4–44 If you are troubleshooting in the Output Amplifier and are not sure if A2Q301/2 is at fault, place a short across A2CR306 while making voltage level and symmetry measurements. Be sure to remove this short when troubleshooting is completed.

4–45 Troubleshooting Tips

4–46 Amplifier symmetry in the X1, X10 Preamplifier can be determined by checking voltages at collectors of A2Q107a/Q107b. If voltages of proper amplitude and symmetry are obtained here with Channel A vernier **20** in Cal detent, you may be reasonably sure the entire amplifier is symmetrical. (Check A2Q207a/Q207b in Model 1220A Channel B).

4–47 Don't overlook A2U102 (A2U202 in Channel B) transistors connected to pins 1, 2, 3, 4, 5, 12, 13, 14. These transistors serve as Current Sources for both Preamplifiers and must be operating properly to ensure correct Preamplifier operation.

4–48 Note variable capacitors A1C420/C421. These capacitors are solely for pulse response. They consist only of short lengths of isolated wire near the cases of transistors A1Q409/Q410. Do not change adjustment when checking voltage values and symmetry.

4–49 Horizontal Circuits

4–50 No Horizontal Deflection and Defective Sweep

4–51 The easiest way to start troubleshooting these circuits is by checking the condition of the Hori-

zontal Output Amplifier. Set X–Y/SWP pushbutton **15** to X–Y position. Connect PROBE ADJ **7** to CHANNEL A INPUT **23**. It may be necessary to adjust INTENSITY **2** and horizontal POSITION **5** to bring two dots into view at center.

4–52 Rotate horizontal POSITION **5** from extreme cw position to extreme ccw position and observe that dots disappear off the screen to the right and left respectively. Return POSITION control **5** to midrange position. Now, rotate expand control **7** to extreme cw position and note dots are approximately 6 divisions apart.

4–53 If these conditions are met, the Horizontal Output Amplifier is working properly. However, if these conditions are not met, it is necessary to troubleshoot the Output Amplifier as follows:

Monitor voltages at the emitters of A1Q15/Q16. Adjust POSITION control **5** until these voltages are equal.

Monitor voltages at collectors of A1Q19/Q20. Verify that they are symmetrical. If not satisfactory check current sources Q21 to Q24.

4–54 No Sweep

4–55 Check A1TP4 and A1MC5b pin 10 waveforms. If the latter is low, the ramp should function.

4–56 Sweep on Auto Mode Only

NOTE... Some combinations of low frequency input and very low sweep speeds may produce random triggering. This is because the signal frequency approaches the operating time of the ramp switch and the automatic bright line circuit. If your application requires frequent use under these conditions, the hold-off can be lengthened by increasing the value of C14.

4–57 Confirm trigger is available at A1TP2. Check MC7a pins 4 and 5 are high, if so, check trigger output (pin 6). If MC7a satisfactory, check inverters MC1a/b/c and verify that MC3d pin 11 delivers a narrow (about 25ns) pulse.

4–58 Logic can also be verified by setting control **15** to X–Y, when MC5b and MC6a will be cleared. Note, however, that MC5b is preset at the same time and that pins 11 and 10 will, therefore, **both** be high.

4–59 Set X–Y/SWP **15** to X–Y. Start at A1TP2 and while monitoring voltage, rotate TRIGGER LEVEL control **8** from 3 o'clock position back to 9 o'clock position. Voltage at A1TP2 should go from approximately +2.8V to approximately +0.1V. Then monitor voltage at A1MC7a pins 4 and 5 which should be high. Monitor A1MC7a pin 6 while rotating TRIGGER LEVEL from 3 o'clock position to 9 o'clock position; the MC state should be low and then high respectively. Follow change of state thorough MC1a, b and c.

4–60 Double Trigger

4–61 If sweep double triggers, check that a narrow negative pulse appears at MC3d pin 11.

4–62 No Auto Sweep

4–63 Check A1 MC3a, A1MC5b and the monostable A1MC6. If using a voltmeter, do not apply any signals to oscilloscope. Note that onto sweep can be disabled if TRIGGER LEVEL **8** is centered (symptom : faint or flickering trace).

4–64 If no Trigger in EXT Trigger Mode but INT is working

4–65 In this condition, it is most likely that the Ext Input Buffer Amplifier is not working. This circuit can be corrected by normal troubleshooting of the components.

4–66 If no Trigger in TV Mode

4–67 If triggering is possible in INT, EXT and LINE, apply a TV signal to input **23** and set amplitude for a 3-div. deflection. With control **6** set to 50μSEC/DIV, line sync pulses should be present at MC2b pin 6 and inverted at TP3. MC8Q should be high. With control **6** set to 0.1m SEC/DIV, MC2a pin 3 output should clock MC8.

4–68 If no Trigger in INT Mode

4–69 Check first to see if EXT, LINE and TV Modes are triggering. If they are, check A2Q110, CR110, CR113, A1CR 213, Q210.

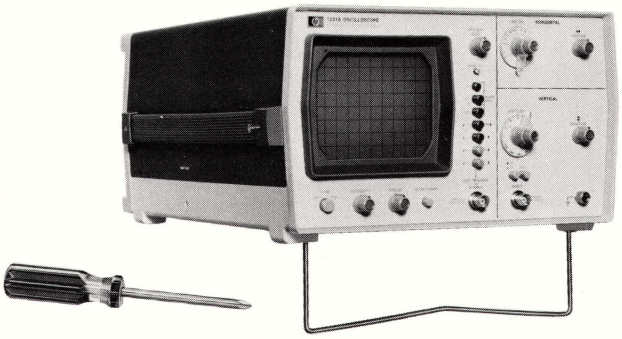
4–70 If no Triggering in LINE Mode

4–71 Check first that INT, EXT and TV are working. If they are, check +8V trigger pulse from A2R12 and power supply circuit.

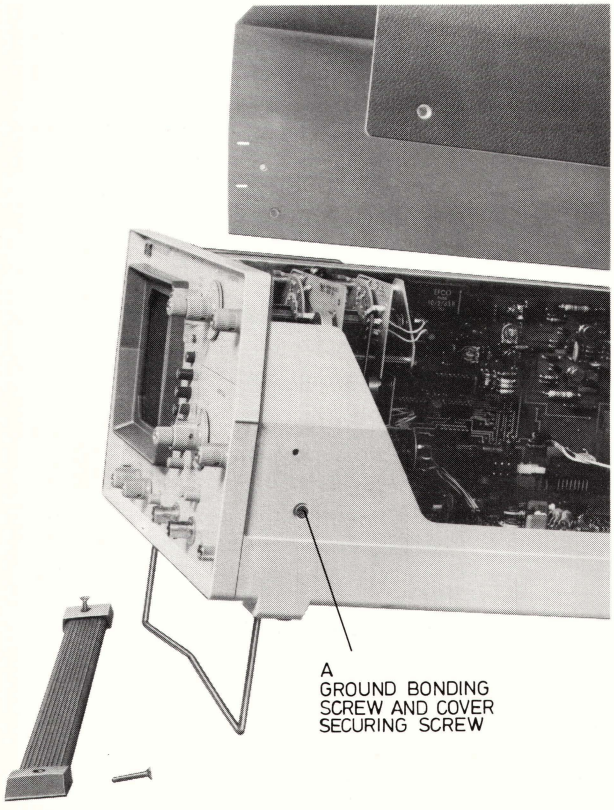
4–72 REMOVAL OF ASSEMBLIES

4–73 Cover

4–74 Unplug power cord. Remove the four screws from the sides of the instrument and lift the cover off.

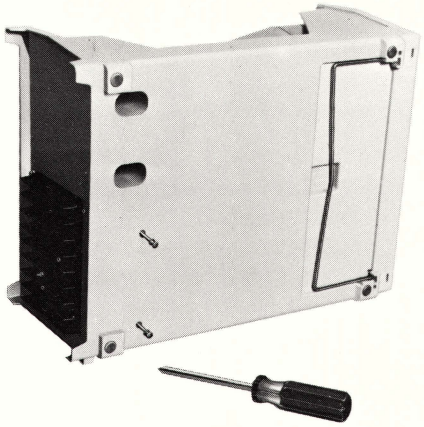


Note that it is important to replace screw A (see figure below) when operating the instrument without the cover. This screw connects interior metalizing of cabinet with the internal grounding system.

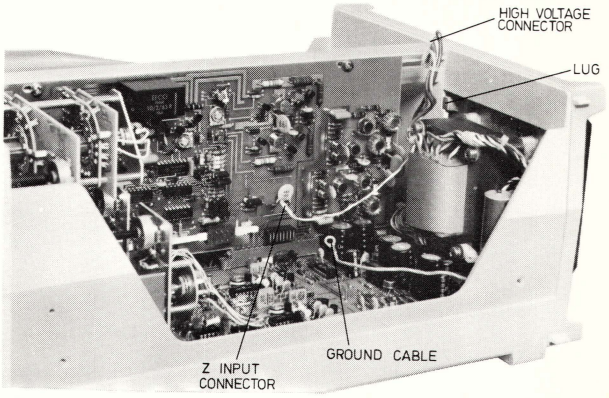


4–75 Heat Sink Assembly

4–76 Remove the two heat sink screws from the underside of the case. See figure top right.



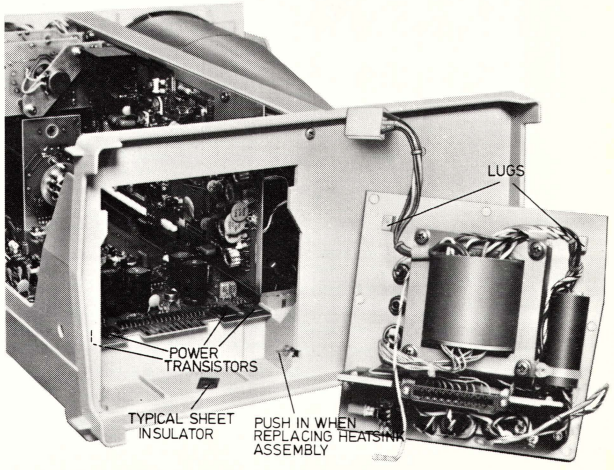
Disconnect the high voltage connector, the Z input connector and the ground cable. Lift the assembly to disengage the lugs and pull it out through the rear panel.



To replace assembly:

ensure sheet insulators are in place over power transistors and that silicon grease is applied generously to their surfaces.

To ensure line switch actuating pin does not foul heat sink assembly, release LINE pushbutton by pressing against actuating pin and, at the same time, releasing the LINE button **1**, pull and turn button through 90 degrees so that it stays out.



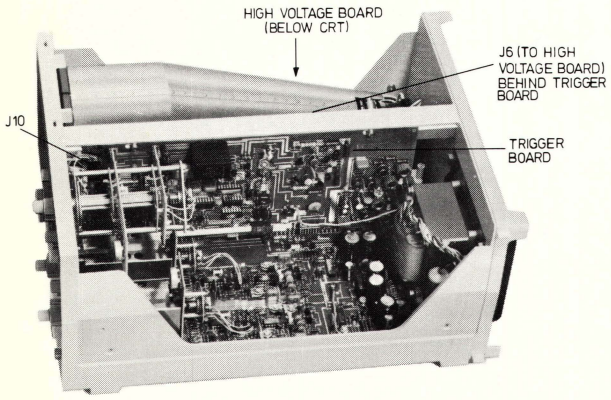
Replace heat sink assembly.

Replace screws. Tighten to ensure good thermal contact.

Release LINE button by turning; check operation.

4–77 Circuit Boards

4–78 Remove the heat sink assembly. Disconnect connectors J6 and J10. Remove all knobs in the HORIZONTAL and VERTICAL panels (note, set screws have socket heads). Remove rings from all three BNC connectors. Remove the two screws from the top edge of the trigger board and ease away from rail. Taking care not to damage pins on rear of trigger board, pull the boards toward the rear, unplug the trigger board from the amplifier board and lift them out, individually.



4–79 Cathode Ray Tube (CRT)

WARNING

IMPLOSION HAZARD. Handle CRT carefully

4–80 To remove CRT (with shield) from the instrument:

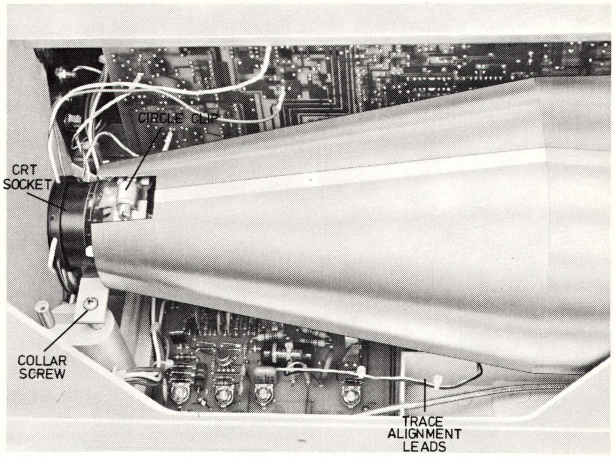
Disconnect the trace alignment leads.

Disconnect the leads from the trigger boards.

Remove CRT collar screws.

Lever collar base away from mounting.

Lift rear of CRT, remove CRT socket and lift away from instrument.



To replace CRT and shield, reverse this procedure. If the CRT is to be replaced by a new tube, remove CRT and shield as above then;

Mark the orientation of CRT base and CRT collar on the shield using a pencil.

Slacken circle clip.

Pull off collar and circle clip.

Remove rubber ring at face of CRT.

Pull CRT out from shield.

Ensure that a flat rubber ring is fitted to neck of new CRT near base.

Insert new CRT into shield.

Align CRT base spigot with mark on shield.

Fit rubber ring at face of CRT.

Place CRT and shield face down on a smooth surface.

Push down on CRT base for firm fit into rubber ring at face.

Fit collar and circle clip on neck of tube over rubber ring. Align collar with mark on shield and push towards CRT face so that the shield is firmly clamped.

Clamp collar, taking care not to overtighten the circle clip. Preferably use a torque screwdriver set to 0.11 kg-m (10 in-lb).

4–81 Attenuator Assembly

4–82 The attenuator shield is soldered to the printed circuit board at two points. If the shield is removed in the process of servicing the switch assembly, replace the shield making sure both points are solidly soldered to the board before performing any further checks or adjustments.

4–83 ACCESS TO REAR OF TRIGGER BOARD

4–84 When troubleshooting trigger amplifier, access to the printed track can be made by removing CRT collar screws, easing the CRT backwards and then swinging the screen end of the CRT away from the trigger board.

WARNING

IMPLOSION HAZARD. Handle CRT carefully. DANGEROUS VOLTAGES. Switch off and disconnect oscilloscope from supply before moving CRT. Use special caution when operating instrument with CRT displaced.

Alternatively, extender board (part number 5060–0049) is available. This fits in place of trigger board which can then be operated in a position vertically above its usual position.

4–85 REPAIRING CIRCUIT BOARDS

4–86 This instrument uses etched circuit boards with plated-through component holes. This allows components to be removed or replaced by unsoldering or soldering from either side of the board. When removing large components, such as potentiometers, rotate the soldering iron tip from lead to lead while applying pressure to the part to lift it from the board. HP Service Note M-20E contains additional information.

4–87 Semiconductor Removal and Replacement

4–88 When removing a semiconductor, use long-nosed pliers as a heat sink between the device and the soldering iron. When replacing a semiconductor, ensure sufficient lead length to dissipate the soldering heat by using the same length of exposed lead as used for the original part. Refer to figure 5–2 for the power transistors.

4–89 Integrated Circuit Replacement

CAUTION

To avoid damaging integrated circuits when removing or replacing them, carry out the following procedure carefully.

4–90 Soldered integrated circuits can be removed with soldering irons which simultaneously heat all connections. Soldering irons with built-in desoldering tools also facilitate quick removal.

Use the following procedure for removing an integrated circuit with a standard soldering iron.

Heat lead solder joint. Use small tip.

When solder is fluid, remove with desoldering tool.

Repeat for each lead until all leads are free.

Grasp each lead with long-nosed pliers and check that it is mechanically free from circuit board.

When all leads are free, carefully remove integrated circuit. Dual in-line type can be removed by gently gripping top and bottom with long-nosed pliers and rolling circuit out.

Use desoldering tool or toothpick to remove all remaining solder from circuit board holes.

CAUTION

Be careful not to damage the integrated circuit with excessive heat. Work quickly.

Insert replacement integrated circuit into circuit board and solder in place.

4–91 When replacing an integrated circuit, note the mark or notch used for orientation. The component-identification photographs and the integrated circuit pin-location diagrams in this manual show the correct orientation.

4–92 Transistor Heat Sink Removal

4–93 Carefully pull away from transistor body.

CAUTION

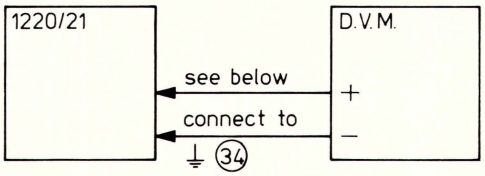
When replacing heat sinks, support the bottom of the transistors to avoid lead damage caused by downward pressure.

ADJUSTMENTS

Table 4–1. Test Instruments Required

Instrument or Accessories	Brief Specification
Voltmeter Calibrator	10mV – 50V p-p ±0.2% 0 – 50 MHz
Square Wave Generator	1 kHz – 1 MHz Risetime < 5nsec
Oscillator*	50 kHz – 15 MHz
Time Mark Generator	Pulse range from 0.1μ sec – 0.5msec±1%
Digital Voltmeter	0.1V – 100V±0.1%
DC-Volt-Ohm-Meter	1mV – 300V 1Ω – 100MΩ
Oscilloscope	5mV – 10±3% 35 MHz – 50 MHz
TV Pattern Generator	TV Signals to local standard
Male BNC to Male BNC cable	50Ω
BNC TEE 1 male 2 female	50Ω
50Ω Feedthrough Termination	50Ω
1000:1 High Voltage Divider	±2%
Trimmer Capacitor	9–35pF
Resistor	1MΩ± 1%
Variable transformer	100 – 250V, 50/60 Hz > 50VA
AC Voltmeter	150, 300V, 50/60 Hz, 1%

Table 4–2.01. Adjustment Procedure: Low Voltage Power Supply



Initial control settings as figure 2–1

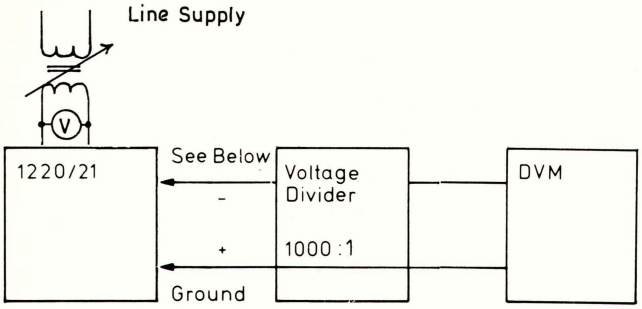
The +95V supply is an adjustable reference for the ± 12 Volt supplies, and the +210 Volt supply. It is normally adjusted to produce highest accuracy on the +12 Volt supply.

STEP	ACTION	RESULT
1	Connect Digital Voltmeter – (or ⏚) lead to the jack **34** on Model 1220A/1221A rear panel.	
2	Connect Digital Voltmeter + lead to +12V test point on A2.	
3	Adjust A2R10 until +12V supply gives reading of	+12V ± 0.05V
4	Transfer Digital Voltmeter to +5V test point on A2	+5V ± 0.25V
5	Transfer Digital Voltmeter to –12V test point on A2	–12V ± 0.3V
6	Transfer Digital Voltmeter to +95V test point on A2	+95V ± 2V
7	Change Digital Voltmeter range, if necessary, and connect to +210V test point on A2.	+210V ± 20V
8	Disconnect Digital Voltmeter.	

*An a.c. voltmeter (100mV ±1%, to 20 MHz) will be needed if available oscillator is uncalibrated.

ADJUSTMENTS

Table 4–2.02. Adjustment Procedure: High Voltage Supply



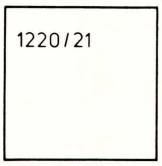
Initial control settings as figure 2–1

For this check, the line voltage must be within 1% of the nominal voltage set on the line voltage selectors **31** .

STEP	ACTION	RESULT
1	Set LINE SELECTOR **31** to 220V.	
2	Set TIME/DIV **6** to 5ms	
3	Set A3R1 so that no trace modulation is apparent.	
4	Set variable transformer for a reading of 220V.	
5	Connect 1:1000 voltage divider to A3TP2	
6	Adjust A3R30 for a DVM reading of 1.96V ±5mV.	
7	Set variable transformer for a reading of 198V on the voltmeter.	
8	Set A3R1 so that no trace modulation is apparent.	
9	Set variable transformer for a reading of 232V.	
10	Check that no trace modulation is apparent. If necessary, readjust A3R1 and repeat steps 7, 8, 9 and 10.	
11	Repeat steps 4, 5 and 6.	
12	Disconnect variable transformer, set LINE SELECTOR to appropriate line voltage.	

NOTE. This procedure may need to be modified if line voltage lies outside 100, 110, 220 or 240V +5%, –10%. Refer to paragraph 3–66.

Table 4–2.03. Adjustment Procedure: Intensity Limit, Astigmatism Trace Alignments



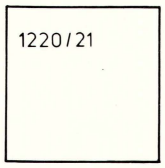
Initial control settings as figure 2–1

STEP	ACTION
1	Set X–Y/SWEEP pushbutton **15** to X–Y position to disable automatic bright-line sweep.
2	Center beam using POSITION controls **5** / **18** .
3	Rotate INTENSITY **2** to 10 o'clock position.
4	Adjust Intensity Limit adjust A3R4 so beam is just extinguished.
5	Adjust INTENSITY **2** to obtain normal spot brightness.
6	Adjust Astigmatism adjustment A3R2 and Focus **3** to get a sharp, round dot.
7	Set X–Y/SWEEP pushbutton **15** to SWEEP position.
8	Adjust Trace Align adjustment A3R3 so that trace is parallel with horizontal graticule lines. Local magnetic field affects this setting.
9	Replace safety cover on high voltage board.

Test and Adjustment Points are indicated on Figure 4–1, Page 4–15

ADJUSTMENTS

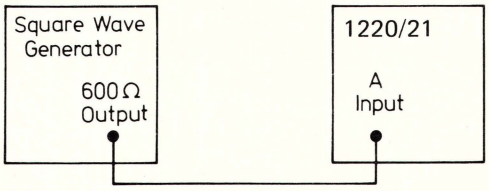
Table 4–2.04 Adjustment Procedure: Vertical Preamplifier Balance



Initial control settings as figure 2–1

STEP	ACTION
	NOTE: Use CHANNEL A on Model 1220A. Use VERTICAL on Model 1221A.
1	Press GND pushbutton **21** (VERTICAL DISPLAY A on Model 1220A).
2	Set VOLTS/DIV switch **19** to 20mV position and use POSITION control **18** to set trace on center horizontal graticule line.
3	Set VOLTS/DIV switch **19** to 2mV position and adjust X1/X10 adjustment A2R114 until trace is re-centered.
4	Repeat steps 2 and 3 until no trace shift occurs when VOLTS/DIV switch **19** is moved from 20mV to 2mV position.
5	Set VOLTS/DIV switch **19** to 100mV position and use POSITION control **18** to set trace on center horizontal graticule line.
6	Set VOLTS/DIV switch **19** to 50 mV position and adjust X1/X2 adjustment A2R148 until trace is positioned on center horizontal graticule line.
7	Repeat steps 5 and 6 until no trace shift occurs when VOLTS/DIV switch **19** is moved from 100mV to 50mV settings.
8	Set VOLTS/DIV switch **19** to 100mV and use POSITION control **18** to set trace on center horizontal graticule line.
9	Set VOLTS/DIV switch **19** to 20mV position and adjust X1/X5 adjustment A2R175 until trace is re-centered.
10	Repeat steps 1 through 9 for CHANNEL B on Model 1220A.

Table 4–2.05 Adjustment Procedure: Compensation of Vertical Attenuator(s)

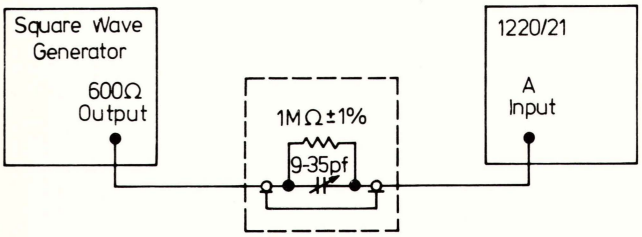


Initial control settings as figure 2–1

STEP	ACTION
	NOTE: These adjustments are necessary only if repairs have been made to the attenuator assembly.
1	Set Model 1220A/Model 1221A VOLTS/DIV switch **19** to 0.2V setting and HORIZONTAL TIME/DIV switch **6** to 20μsec setting.
2	Set Square Wave Generator controls for 10kHz output with sufficient amplitude to produce 6 divisions of vertical deflection.
3	Adjust A2C102 compensation adjustment to achieve squarest corners on the displayed waveform.
4	Set CHANNEL A VOLTS/DIV switch **19** to 2V settings and adjust Square Wave Generator output for 6 divisions of vertical display.
5	Adjust A2C105 compensation adjustment to achieve squarest corners on displayed waveform.
6	Repeat steps 1 through 5 on Channel B attenuator for Model 1220A.

ADJUSTMENTS

Table 4–2.06. Adjustment Procedure: Input Capacitance

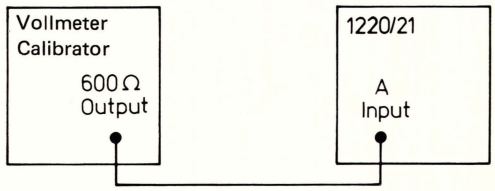


Initial control settings as figure 2–1

NOTE: This procedure is only necessary when repairs have been made to the attenuator. The input capacitance can be measured directly at the vertical channel INPUT connector **23** **29** by using an LC Meter. The following procedure is to be used only if an LC Meter is not available. A shield, as indicated by the dotted line in the above drawing, should be used to keep stray capacitance from affecting measurements.

STEP	ACTION
1	Set HORIZONTAL TIME/DIV **6** to 20μsec setting, CHANNEL A VOLTS/DIV **19** to 2mV setting. Set Square Wave Generator for 1kHz signal.
2	Adjust Square Wave Generator amplitude to produce 6 divisions vertical deflection, and adjust 9–35pf trimmer to give squarest corner on waveform.
3	Set VOLTS/DIV switch **19** to 0.2V setting and set Square Wave Generator to produce 6 divisions vertical deflection.
4	Adjust Input Capacitor A2C103 for best possible waveform.
5	Set VOLTS/DIV switch **19** to 2V setting and adjust Square Wave Generator to produce 6 divisions vertical deflection.
6	Adjust Input Capacitor A2C106 for best possible waveform.
7	Repeat steps 1 through 6 for CHANNEL B. Use VOLTS/DIV switch **25** and Input Capacitors A2C203 and A2C206.

Table 4–2.07. Adjustment Procedure: Vertical Gain



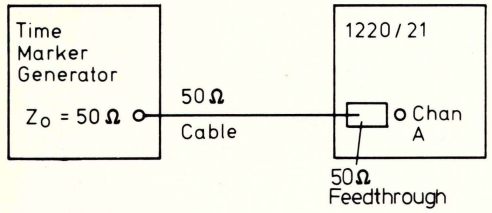
Initial control settings as figure 2–1

NOTE: During this procedure , be sure vertical verniers **20** / **26** are in full counterclockwise (detent) position.

STEP	ACTION
1	Set CHANNEL A VOLTS/DIV switch **19** to 100mV setting and HORIZONTAL TIME/DIV switch **6** to 1msec setting.
2	Set Oscillator for 400kHz at exactly 500mV p-p amplitude.
3	Adjust Vertical Gain adjustment A2R162 for exactly 5 divisions of vertical deflection. This ensures 3% accuracy in the vertical amplifier.
4	Repeat steps 1 through 3 on CHANNEL B for Model 1220A. Set VERTICAL VOLTS/DIV switch **25** , and adjust A2R262 for Channel B.

ADJUSTMENTS

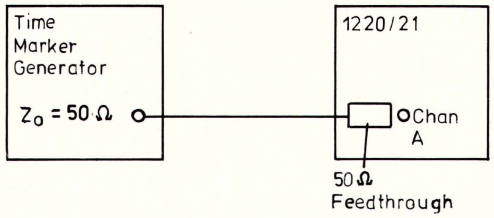
Table 4–2.08. Adjustment Procedure: Sweep Speed



Initial settings as figure 2–1

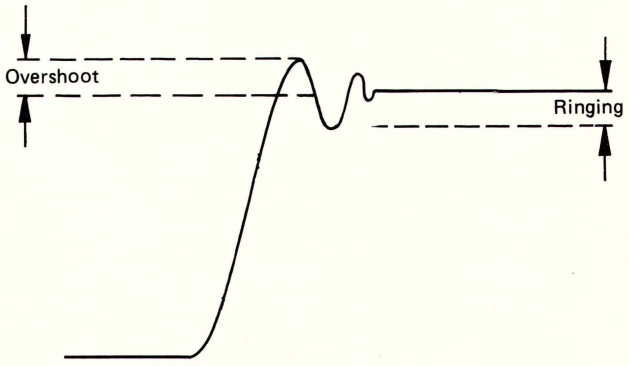
STEP	ACTION
1	Set generator for a 1ms marker interval.
2	Adjust A1R97 so that markers lie on vertical graticule lines (use POSITION control 5 to align first marker with edge of graticule).
3	Set generator for a 0.2μs marker interval and oscilloscope sweep to 0.2μs/div.
4	Adjust A1C28 so that time markers again co-incide with vertical lines of graticule.
5	Set calibrator in turn to 0.1μs and 0.5μs and verify sweep calibration for corresponding oscilloscope settings. If necessary, re-adjust A1C28 for best compromise.

Table 4–2.09. Calibration Procedure: Pulse Response



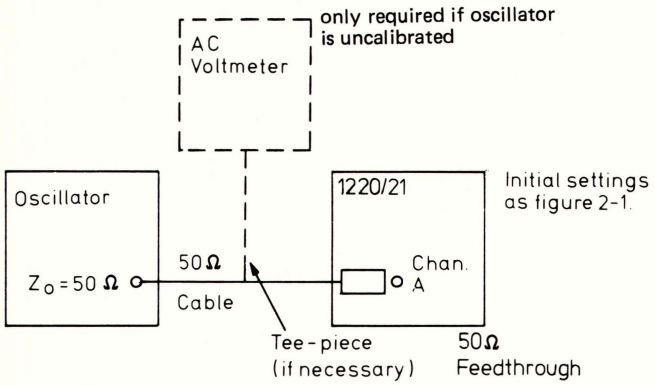
Initial settings as in figure 2–1

STEP	ACTION	RESULT
1	Set attenuator to 100mV/div. Set sweep to 0.1μs/div. Set generator for 1 MHz square wave, adjust output amplitude for a 6-division vertical display on the oscilloscope.	
2	Adjust A1C420 and C421 for optimum pulse response in terms of ringing, overshoot and rise time	



ADJUSTMENTS

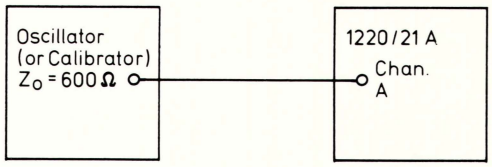
Table 4–2.10. Adjustment Procedure: Bandwidth



Initial settings as in figure 2–1

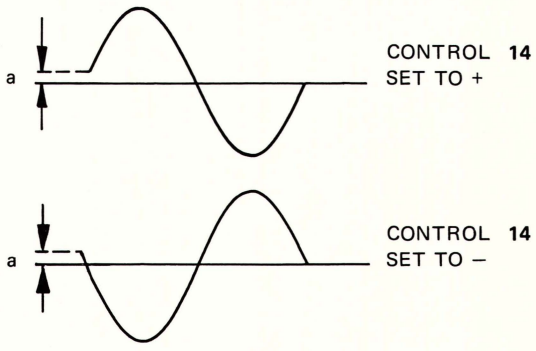
STEP	ACTION
1	Set oscillator to 50kHz at an output which produces a vertical deflection of 6 divisions.
2	Set oscillator to 15 MHz at the same amplitude. Adjust A1C420/C421 to obtain a vertical deflection ⩾4.3 divisions
3	Optimize adjustment by repeating previous table.

Table 4–2.11. Adjustment Procedure: Trigger Amplifier Balance



Initial settings as in figure 2–1

STEP	ACTION
1	Remove connector J10 (between A1 and front panel) so that TRIGGER LEVEL control **8** is inoperative.
2	Set oscilloscope sweep to 0.1ms/div, sensitivity to 100mV/div, and +/– **14** to +.
3	Set generator for 1 kHz sinewave at 600mV p-p.
4	Adjust A1R66 so that both start at the same point.

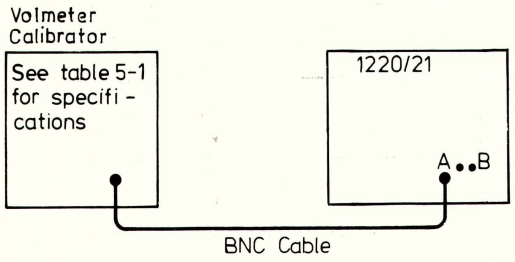


5	Reconnect J10.

End of Adjustment Procedure

PERFORMANCE TESTS

Table 4–3.01. Performance Test: Vertical Sensitivity

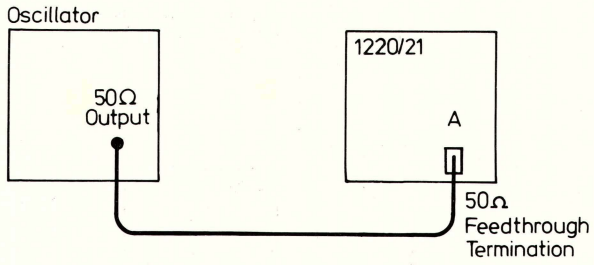


Initial control settings as figure 2–1

VOLTMETER CALIBRATOR	1220A/1221A VOLTS/DIV	RESULTS	
50Vpp	10V	5 div	±3%
30Vpp	5V	6 div	
10Vpp	2V	5 div	
5Vpp	1V	5 div	
3Vpp	.5V	6 div	
1Vpp	.2V	5 div	
.5Vpp	.1V	5 div	
.3Vpp	50mV	6 div	
.1Vpp	20mV	5 div	
50mVpp	10mV	5 div	±5%
30mVpp	5mV	6 div	
10mVpp	2mV	5 div	

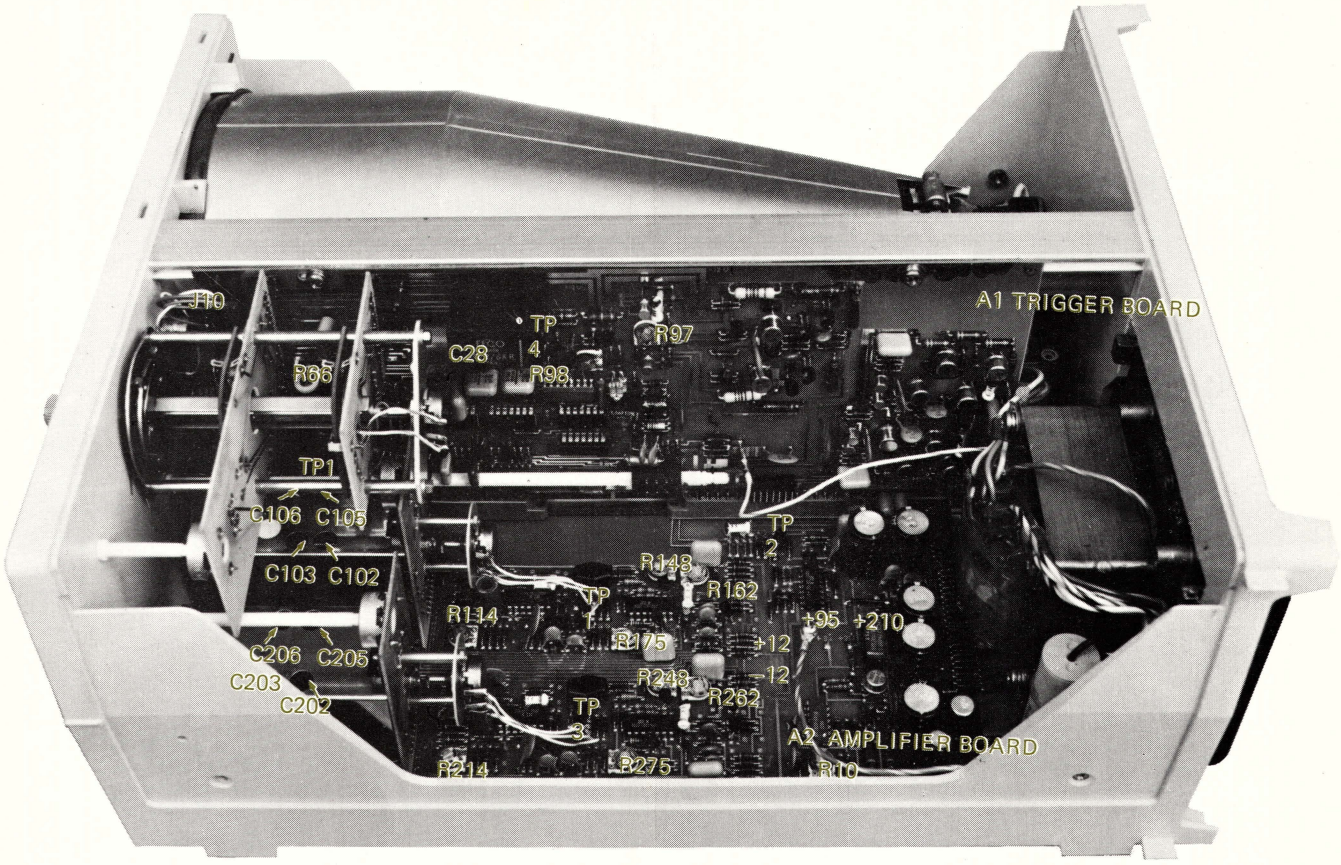
Transfer input to channel B, select channel B and repeat above tests.

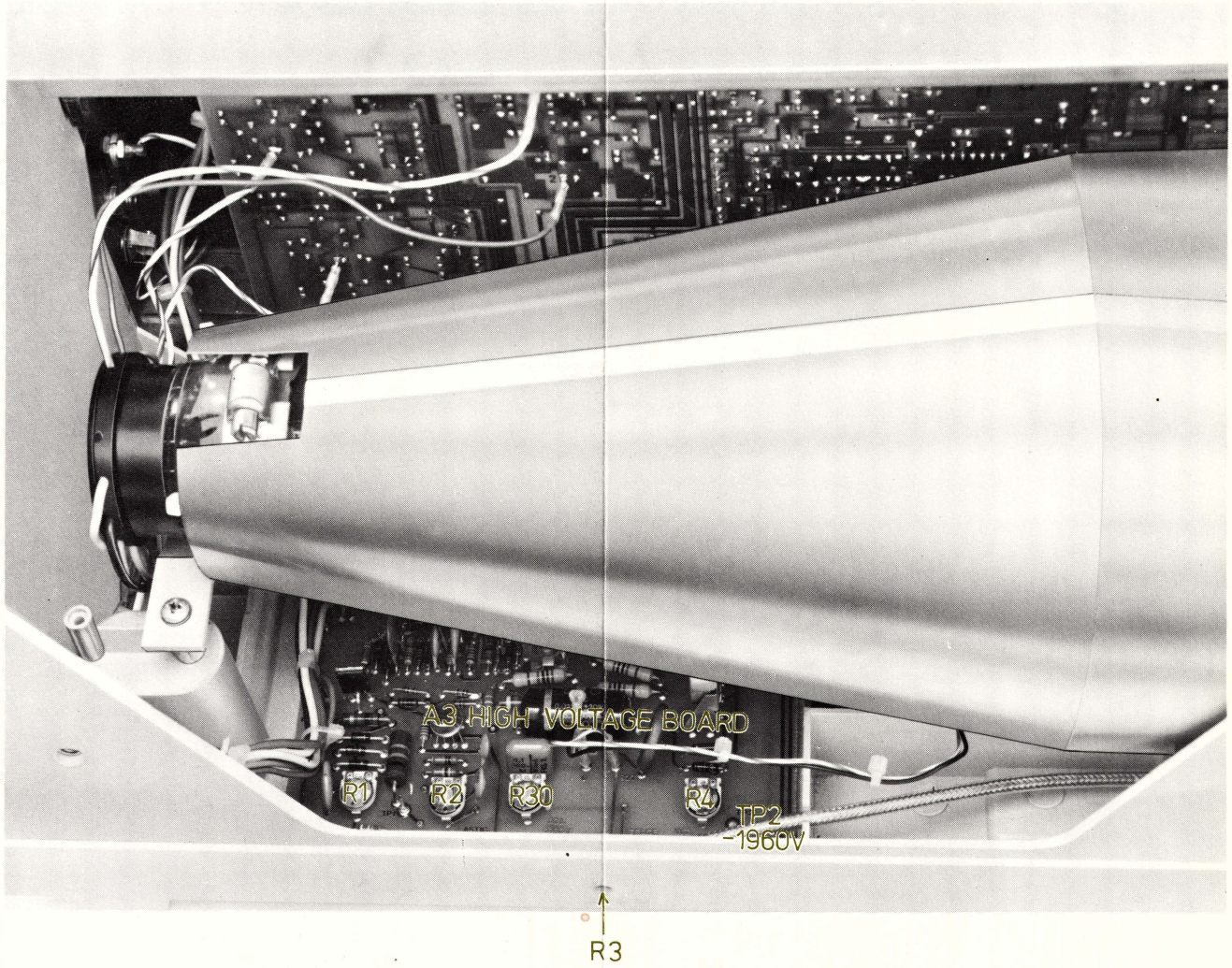
Table 4–3.02. Performance Test: Internal Trigger Sensitivity



Initial control settings as figure 2–1 except: VOLTS/DIV (19) .1V
TIME/DIV (6) .1us

STEP	ACTION
1	Set oscillator frequency to 15 MHz.
2	Set oscillator amplitude for a 1220A/1221A display of 2 div.
3	Adjust the 1220A/1221A TRIGGER LEVEL to obtain a stable display.
4	Depress the "+/–" button **14** for negative triggering:; display should change polarity and remain stable.


J10
TP 4
C28
R97
R98
R88
A1 TRIGGER BOARD
TP1
C106
C105
C103
C102
TP 2
R148
R162
TP
R114
+95
+210
R175
+12
C206
C205
C203
C202
R248
-12
R262
TP 3
A2 AMPLIFIER BOARD
R214
R275
R10

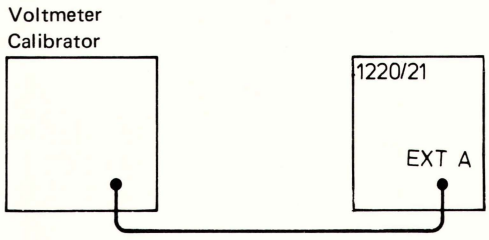


WARNING
VOLTAGES DANGEROUS TO LIFE

A3 is shown with protective cover removed. Use extreme caution when troubleshooting with this cover removed.

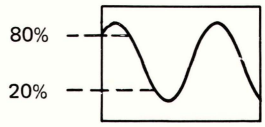
Figure 4–1. Location of Calibration Controls

Table 4–3.05 Performance Test: Trigger Level and Polarity Controls Check

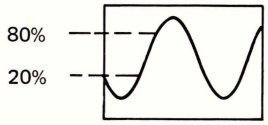


Initial control settings as figure 2–1 except:
VOLTS/DIV 0.1V

STEP	ACTION
1	Set calibrator amplitude to 0.6Vpp at 400 Hz.
2	Set 1220A/1221A TIME/DIV switch to 1ms.
3	Set TRIGGER LEVEL slowly ccw and cw. Trigger point should shift from 20% to 80% of positive slope.

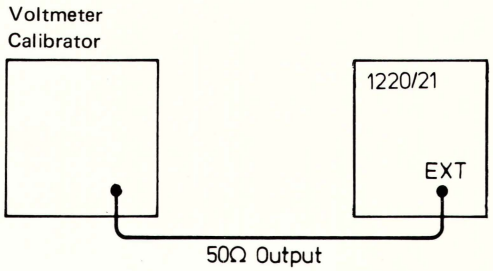


4	Depress the "+/–" switch for negative triggering. Repeat step 3 for negative slope.



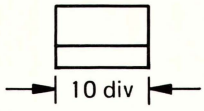
← Tables 4–3.03 and 4–3.04

Table 4–3.06. Performance Test: Deflection Check



Initial control settings as figure 2–1 except:
X–Y/SWP pressed

STEP	ACTION
1	Set calibrator amplitude to 10Vpp. The horizontal trace should be 10 divisions, ± 0.5 division.



2	Depress the 1:10 switch. The horizontal trace should be 1 division, ±.1 division.

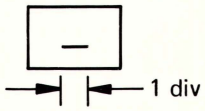
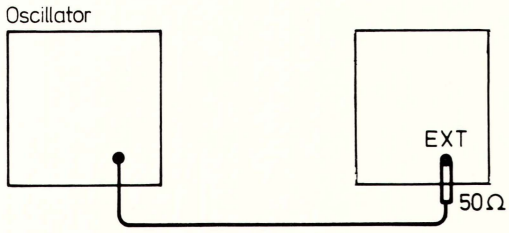


Table 4–3.07 Performance Test: Horizontal Bandwidth Check

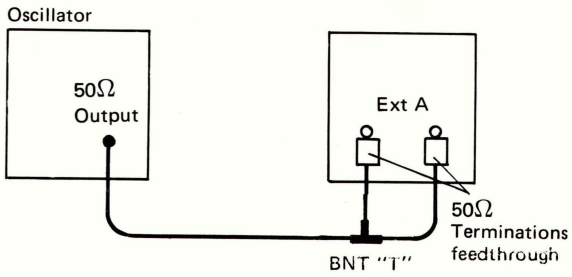


Initial control settings as figure 2–1 except:
X–Y/SWP pressed

1	Set Signal Source to 50kHz
2	Adjust source for 10 div. on 1220A/1221A
3	Observe meter reading
4	Set source to 1 MHz
5	Amplitude check
6	Display should be ⩾7.1 div.

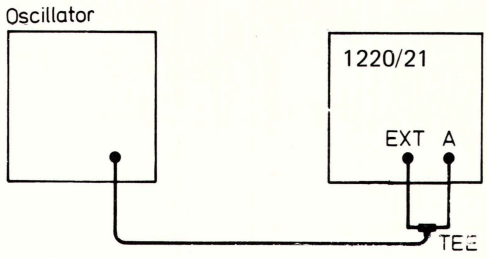
PERFORMANCE TESTS

Table 4–3.03 Performance Test:
External Trigger Sensitivity



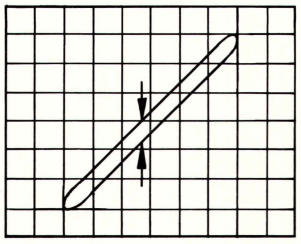
STEP	ACTION
1	Set oscillator amplitude for a 1220A/1221A display of 1 div.
2	Depress the EXT button **11** for external triggering and adjust the 1220A/1221A LEVEL control **8** to obtain a stable display.
3	Release the "+/—" button **14** for positive triggering; display should change polarity and remain stable.

Table 4–3.04. Performance Test: Phase Shift Check



Initial control settings as figure 2–1 except:
X–Y/SWP pressed

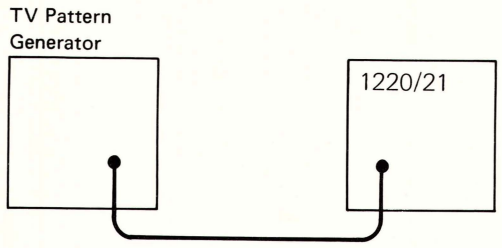
STEP	ACTION
1	Set oscillator to 100kHz.
2	Set ampl. for a 6 div. deflection horizontal and vertical.
3	Phase shift should be $<$ 0.2div.
4	Repeat for channel B..
5	Check that results of table 4–2.10 are met.



$<$ 0.2 div

PERFORMANCE TESTS

Table 4–3.08. Performance Test: TV Sync Separator Check

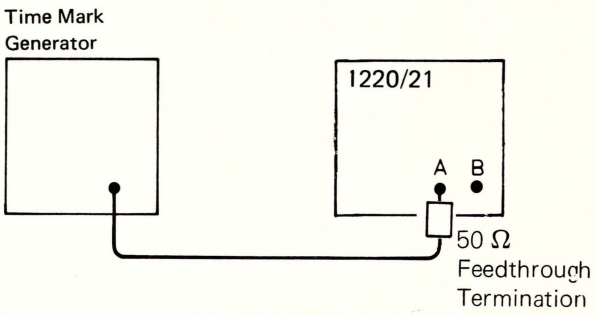


Initial control settings as figure 2–1 except:

VOLTS/DIV	100mV/div
TIME/DIV	.2m s
TV–NORM	pressed

STEP	ACTION
1	Set the TV pattern generator to produce a signal.
2	Select correct signal polarity.
3	Adjust generator amplitude for a display of 3 divisions. 1220A/1221A should trigger on frame pulses.
4	Switch the TIME/DIV switch to 10μs. The 1220A/1221A should trigger on line pulses.

Table 4–3.09. Performance Test: Sweep Accuracy Check

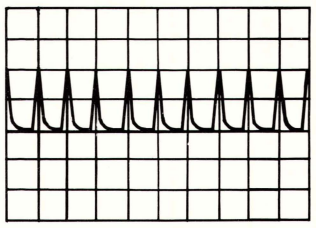


Initial control settings as figure 2–1 except:
VOLTS/DIV 0.1V

TIME MARK INTERVAL	1220A/1221A TIME/DIV SETTING
.1μ	.1μ
.2μ	.2μ
.5μ	.5μ

and so on to .5s

The first time mark should appear at the left edge of the graticule in each setting: the 11th mark should occur within 0.4 div. of the right edge of the graticule.



Set sweep to 1ms/div
Time marker 1msec
11 markers should appear

Turn sweep expander fully Cw
Time interval should be equal or greater than 10 div.

DIAGRAMS AND REPLACEABLE PARTS

Table 5–1. Abbreviations

A	=	Ampere, Assembly	FLM	=	Film	PCAR	=	Polycarbonate
AL	=	Aluminimum	FET	=	Field Effect Transistor	POLYS	=	Polystyrene
AMP	=	Amplifier	GE	=	Germanium	POLYE	=	Polyester
AY	=	Assembly	HC	=	Hot Carrier	Q	=	Transistor
BD	=	Board	IC	=	Integrated Circuit	R	=	Resistor
			J	=	Connector			
C	=	Capacitor	J-FET	=	Junction-Field Effect Transistor	REG	=	Regulator
			K	=	Kilohms	S, SW	=	Switch
CAR	=	Carbon	L	=	Inductor	SI	=	Silicon
CER	=	Ceramic	LIN	=	Linear	SKT	=	Socket
CMT	=	Cermet	LOG	=	Logarithmic	SLTD	=	Selected
CPLR	=	Coupler				T	=	Transformer
CONN	=	Connector	M	=	Megohm	TAN	=	Tantalum
CONT	=	Contact	MC	=	Micro-circuit (e.g. packaged gates,	U	=	Micro (1×10^{-6}), packaged transistors
COMP	=	Composition			inverters, flip-flops)	V	=	Volts, Electronic tubes
CR	=	Diode	MET	=	Metal or Metalized	VAR	=	Variable Value
			MIC	=	Mica			(maximum value shown)
DIG	=	Digital	MP	=	Mechanical part			
			N	=	Negative	W	=	Watts, Cable assembly, working
EY	=	Electrolytic	n, N	=	nano (1×10^{-9})	X	=	Socket
F	=	Fuse, Fixed Value, Farad	OP	=	Operational	Z	=	Zener

Table 5–2. Circuit Diagram Symbols

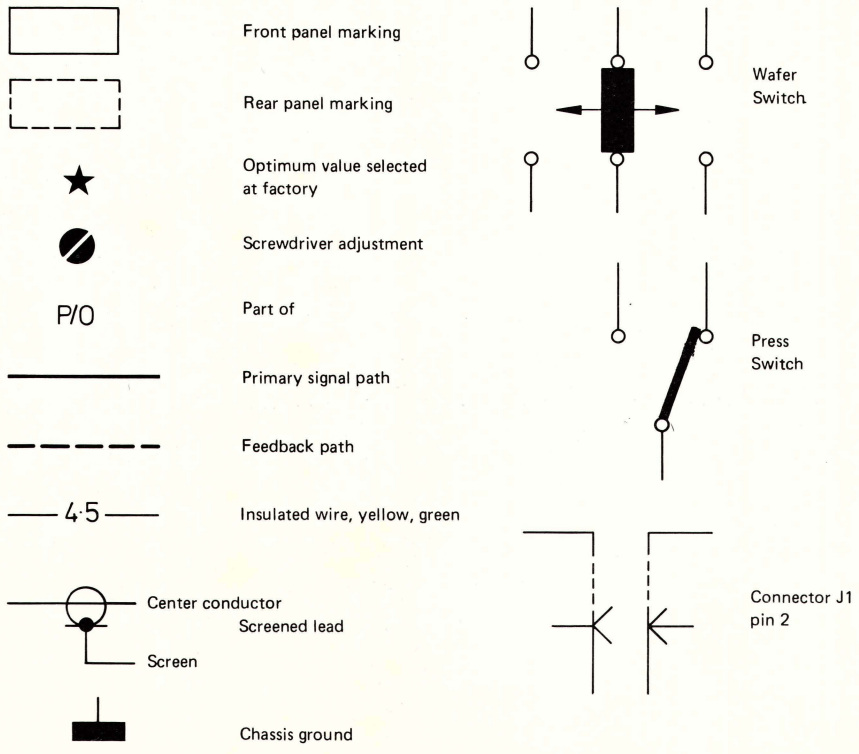


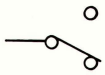
Table 5–2. Circuit Diagram Symbols (cont'd).

Resistor

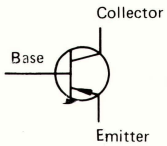
Inductor

Capacitor

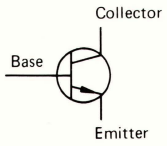
Unless otherwise indicated:
capacitance in microfarads
inductance in microhenries
resistance in ohms.



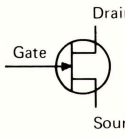
Switch
(unspecified type)



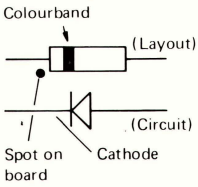
PNP Transistor



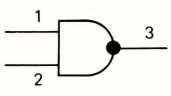
NPN Transistor



n channel
FET

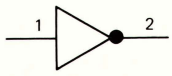


Diode



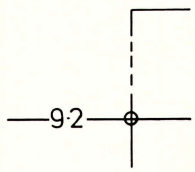
NAND gate. 3 is low (logical 0) when 1 and 2 are both high (logical 1).
NAND gate. 3 is low conditions.

Terminal:	1	2	3
logic state	1	1	0
	1	0	1
	0	1	1
	0	0	1



Inverter

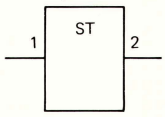
Terminal:	1	2
logic state	1	0
	0	1



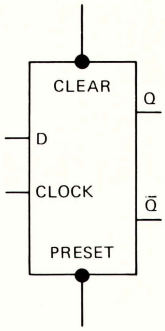
Single wire, identified by color code, connected directly to circuit board.

Color Code

0 – Black
1 – Brown
2 – Red
3 – Orange
4 – Yellow
5 – Green
6 – Blue
7 – Violet
8 – Gray
9 – White



Schmitt Trigger. When input 1 rises above a threshold, the output changes state.

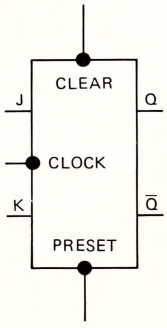


D (data) flip-flop.
Data is transferred from D to Q at each positive clock pulse.

A logical zero on the CLEAR terminal sets Q to logical zero, regardless of clock or data.

A logical zero on the PRESET terminal set Q to logical one, regardless of clock or data.

$\bar{Q}$ is the complement of Q.

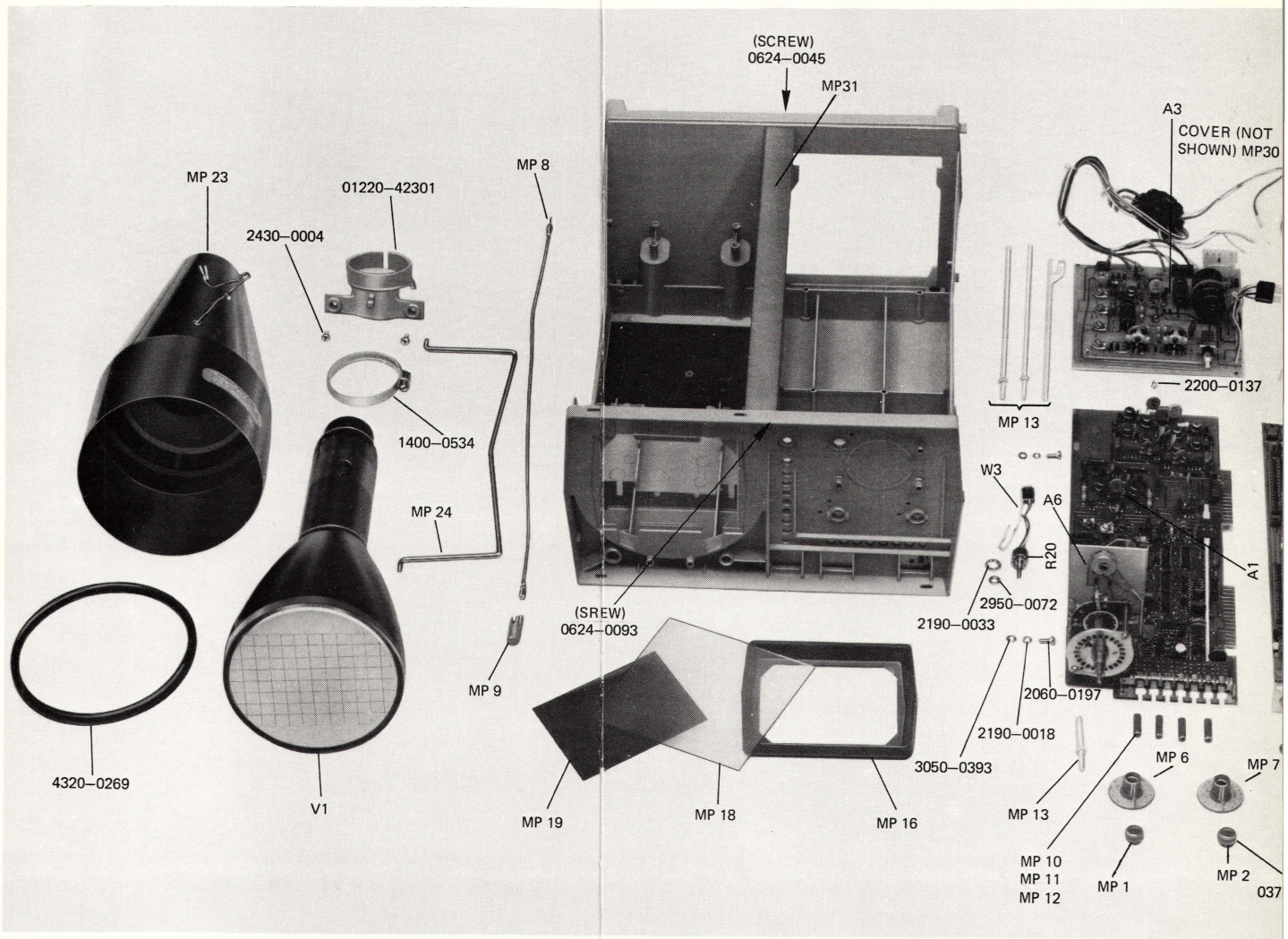


J–K flip-flop.
Flip-flop changes state on negative-going edge of clock pulse provided J, K, CLEAR, PRESET are logical 1.

If J, K are logical zero, flip-flop does not toggle.

If J=1 and K=0, Q=1
If J=0 and K=1, Q=0

Clear, preset and $\bar{Q}$ as for D flip-flops.



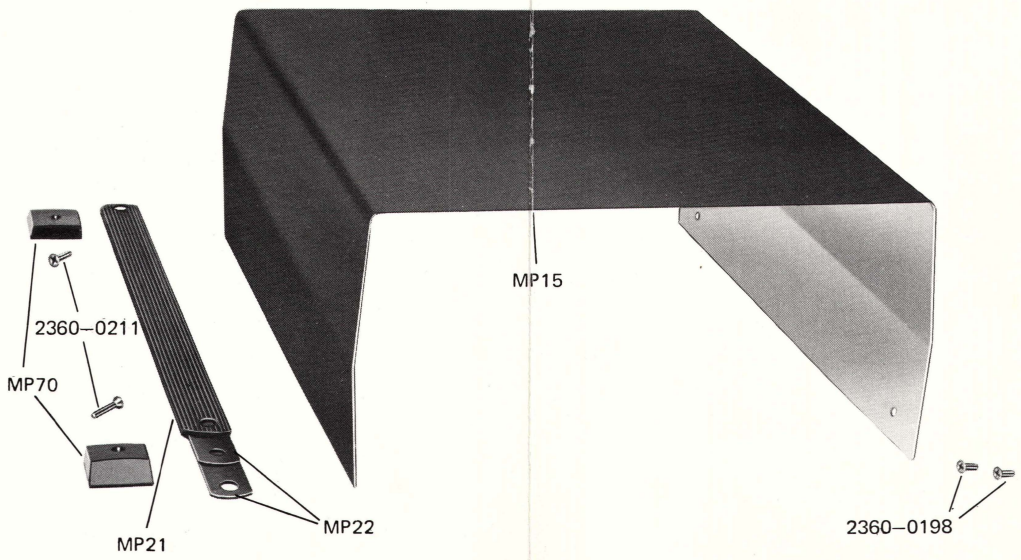


Figure 5–1. Parts identification for main assembly

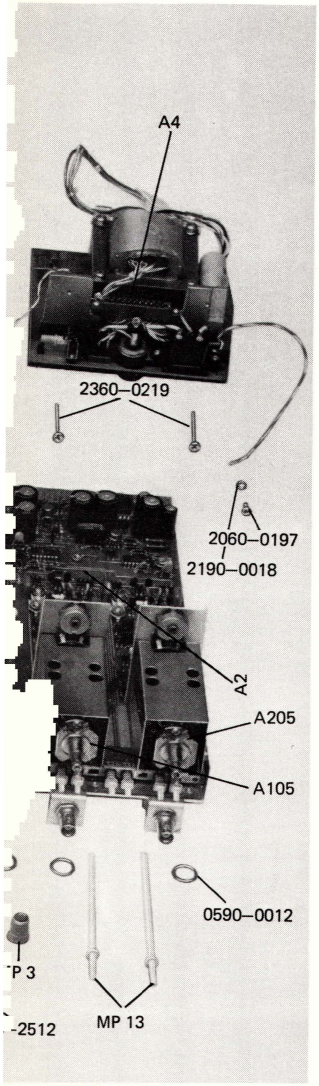


Table 5–3. Replaceable Parts

This list applies to all models 1220A/21A, standard and options 020 (German) and 021 (French). Parts particular to one version are indicated by the name of that version appearing in the Description column.

Component Referencing

The instrument consists of a number of assemblies (A1, A2, etc) mounted in a frame (main assembly). Components mounted on an assembly take the assembly number in addition to a component number. Thus the reference designator A1Q3 means transistor 3 on assembly A1. Components mounted directly on the main assembly take no assembly reference.

Main Assembly

REFERENCE DESIGNATOR	HP PART NUMBER	DESCRIPTION
A1	01220–66501	BD AY TRIGGER (1220A)
A1	01221–66501	BD AY TRIGGER (1221A)
A2	01220–66504	BD AY AMPLIFIER (1220A)
A2	01221–66504	BD AY AMPLIFIER (1221A)
A3	01220–66507	BD AY HV
A4	01220–61101	HEAT SINK AY
F1	2110–0201	FUSE 250V .25A SB
F1	2110–0202	FUSE .5 FER
L1	01220–67701	BOBBIN AY
MP1	0350–0824	KNOB INNER, PTR CW
MP2	0350–0975	KNOB INNER, PTR CCW
MP3	0370–1005	KNOB POINTER
MP4	0370–2512	KNOB CONCENTRIC
MP5	0403–0311	RUBBER FEET
MP6	01220–67401	KNOB AY VOLTS/DIV
MP7	01220–67402	KNOB AY TIME/DIV (ENGLISH)
MP7	01220–67403	KNOB AY TIME/DIV (GERMAN)
MP7	01220–67404	KNOB AY TIME/DIV (FRENCH)
MP8	1500–0375	CABLE BOWDEN
MP9	01220–47401	KNOB POWER
MP10	5040–1126	KNOB PBTN GRAY
MP11	5040–1127	KNOB PBTN GREEN
MP12	5040–1128	KNOB PBTN BLUE
MP13	01220–43201	SHAFT SET (1220A) (MP25 to 28)
MP13	01221–43201	SHAFT SET (1221A) (MP 25,27,28)
MP14	01220–00201	PANEL FRONT (1220A) (ENGLISH)
MP14	01220–00202	PANEL FRONT (1220A) (GERMAN)
MP14	01220–00203	PANEL FRONT (1220A) (FRENCH)
MP14	01221–00201	PANEL FRONT (1221A) (ENGLISH)
MP14	01221–00202	PANEL FRONT (1221A) (GERMAN)
MP14	01221–00203	PANEL FRONT (1221A) (FRENCH)
MP15	01220–04101	COVER HOUSING
MP16	01220–42201	BEZEL
MP17	01220–42301	HOLDER TUBE
MP18	5000–8895	SAFTY PLATE
MP19	4114–0521	PLASTIC SHEET
MP20	01220–44101	COVER HANDLE
MP21	5000–8893	HANDLE SIDE
MP22	5000–8894	HANDLE STRAP
MP23	1220–0202	SHIELD CRT
MP24	1460–0564	STAND TILT
MP25	01220–43203	SHAFT LONG
MP26	01220–43204	SHAFT VERTICAL POSN. (1220A)
MP27	01220–43205	SHAFT TRIGGER BD
MP28	01220–43206	SHAFT BEAM FINDER
MP29	01220–23202	ADAPTER TRIG. LVL. SHAFT (1221A)
MP30	01220–44103	COVER FOR A3 WITH CATCH
MP31	01220–24701	FRAME
R20	2100–0592	R–VAR 10K (TRIG. LVL.)
R159	2100–0592	R–VAR 10K (VERT. POS. 1221A)
W1	8120–1692	PWR CORD SET
W3	01220–61603	CBL AY POT
V1	5083–3853	CRT

Assembly A2 – Amplifier Board Assembly including VOLTS/DIV Switch Assemblies A2 A105/A205

For components in the 200 series (1220A only), refer to corresponding components in the 100 series (e.g. for C227 refer to C127).

Similarly, for components of A205 (1220A only), refer to corresponding components of A105 (e.g. for A205 R101, refer to A105 R101).

Components on Sub-assemblies A105, A205 have the same numerical sequence as components on assembly A2.

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A1	R86	0757–0420	R–F 750 +–1% 1/8W MET FLM
A1	R87	0757–0420	R–F 750 +–1% 1/8W MET FLM
A1A6	R88	0698–5323	R–F 4K +–0.5% 1/8W MET FLM
A1A6	R89	0698–6755	R–F 8K +–0.5% 1/8W MET FLM
A1A6	R90	0698–6871	R–F 10K +–0.5% 1/8W MET FLM
A1A6	R91	0698–6885	R–F 20K +–0.5% 1/8W MET FLM
A1A6	R92	0698–5573	R–F 50K +–0.5% 1/8W MET FLM
A1A6	R93	0698–6770	R–F 100K +–0.5% 1/8W MET FLM
A1A6	R94	0698–6217	R–F 200K +–0.5% 1/8W MET FLM
A1A6	R95	0698–8312	R–F 499K +–0.5% 1/8W MET FLM
A1	R96	0757–0442	R–F 10K +–1% 1/8W MET FLM
A1	R97	2100–2797	R–VAR 4.7K +–20% 1/2W
A1	R98	2100–2800	R–VAR 1K +–20% 1/2W
A1	R99	0757–0442	R–F 10K +–1% 1/8W MET FLM(1220A)
A1	R100	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1	R101	0757–0283	R–F 2K +–1% 1/8W MET FLM
A1	R102	0757–0407	R–F 200 +–1% 1/8W MET FLM
A1	R103	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1A6	R104	2100–0591	R–VAR 25K +–20% 10CC
A1A6	R105	2100–0593	R–VAR 10K +–10% LIN
A1	R401	0757–0282	R–F 221 +–1% 1/8W MET FLM
A1	R402	0757–0282	R–F 221 +–1% 1/8W MET FLM
A1	R403	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R404	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R405	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R406	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R407	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R408	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R409	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R410	0758–0005	R–F 4.7K +–5% 1/4W MET FLM
A1	R411	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R412	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R413	0757–0282	R–F 221 +–1% 1/8W MET FLM
A1	R414	0757–0282	R–F 221 +–1% 1/8W MET FLM
A1	R415	0758–0019	R–F 18K +–5% 1/4W MET FLM
A1	R416	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A1	R417	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A1	R418	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A1	R419	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A1	R420	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A1	R421	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A1	R422	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R423	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R424	0757–0451	R–F 24.3K +–1% 1/8W MET FLM
A1	R425	0757–0451	R–F 24.3K +–1% 1/8W MET FLM
A1	R426	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R427	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R428	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A1	R429	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A1	R430	0757–0394	R–F 51.1 +–1% 1/8W MET FLM
A1	R431	0757–0394	R–F 51.1 +–1% 1/8W MET FLM
A1	R432	0698–4467	R–F 1.05K +–1%, 1/8W MET FLM
A1	S2	3101–0562	SWITCH-PUSHBUTTON
A1	S3	3101–0561	SWITCH-PUSHBUTTON

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A2		01220–66504	BOARD ASSEMBLY AMPLIFIER (1220A)
A2		01221–66504	BOARD ASSEMBLY AMPLIFIER (1221A)
A2	A105	01220–68701	BOARD ASSY - SWITCH
A2	A205	01220–68701	BOARD ASSY - SWITCH (1220A)
A2	C1	0180–0425	C–F 4.7UF –10 +150% 250VDC AL EL
A2	C2	0180–0426	C–F 22UF –10 +150% 250VDC AL EL
A2	C3	0180–0426	C–F 22UF –10 +150% 250VDC AL EL
A2	C4	0180–0425	C–F 4.7UF –10 +150% 250VDC AL EL
A2	C5	0160–3719	C–F 68NF +–10% 20VDC MET POLYC
A2	C6	0160–2140	C–F 470PF +80 –20% 1KV DC CER
A2	C7	0180–0424	C–F 400UF –10 +100% 25VDC AL EL
A2	C8	0180–0423	C–F 100UF –10 +100% 16VDC AL EL
A2	C9	0180–0424	C–F 470UF –10 +100% 25VDC AL EL
A2	C10	0170–0085	C–F 100NF +–20% 50VDC POLYE
A2	C11	0180–0424	C–F 470UF –10 +100% 25VDC AL ELEC
A2	C12	0180–0423	C–F 100UF –10 +100% 16VDC AL EL
A2	C13	0160–2930	C–F 10NF +80 –20% 100VDC CER
A2	C14	0160–2930	C–F 10NF +80 – 20% 100VDC CER
A2	C15	0160–2141	C–F 680PF +80 –20% 1KVDC CER
A2	C101	0160–3581	C–F 100NF +–10% 1KVDC MET POLYE
A2	C102	0121–0060	C–VAR 2–8PF CER
A2	C103	0121–0061	C–VAR 5.5–18PF CER
A2	C104	0140–0191	C–F 56PF +–5% 300VDC MICA
A2	C105	0121–0060	C–VAR 2–8PF CER
A2	C106	0121–0061	C–VAR 5.5–18PF CER
A2	C107	0160–2940	C–F 470PF +–5% 300VDC MICA
A2	C108	0160–3226	C–F 10NF +–10% 400WDC MET POLYE
A2	C112	0150–0059	C–F 3.3PF +–0.25PF 500VDC CER
A2	C115	0160–3208	C–F 25NF +80 –20% 100WVDC CER
A2	C116	0160–3208	C–F 25NF +80 –20% 100WVDC CER
A2	C123	0150–0059	C–F 3.3PF +–0.25PF 500VDC CER
A2	C126	0170–0085	C–F 100NF +–20% 50VDC POLYE
A2	C127	0170–0085	C–F 100NF +–20% 50VDC POLYE
A2	C128	0160–2959	C–F 1NF +80 –20% 1KVDC CER
A2	C129	0160–2959	C–F 1NF +80 –20% 1KVDC CER
A2	C130	0160–2959	C–F 1NF +80 –20% 1KVDC CER
A2	C301	0160–2243	C–F 2.7PF +–0.25PF 500VDC CER
A2	C302	0140–0193	C–F 82PF +–5% 300VDC MICA
A2	C303	0160–2959	C–F 1NF +80 –20% 1KVDC CER
A2	C601	0140–0202	C–F 15PF +–5% 500VDC MICA
A2	C602	0160–0183	C–F 130PF +–5% 300VDC MICA
A2	CR1	1901–0159	DIODE SI 400V .75A
A2	CR2	1901–0159	DIODE SI 400V .75A
A2	CR3	1901–0159	DIODE SI 400V .75A
A2	CR4	1901–0159	DIODE SI 400V .75A
A2	CR5	1901–0033	DIODE SI 180V 200mA
A2	CR6	1901–0033	DIODE SI 180V 200mA
A2	CR7	1901–0033	DIODE SI 180V 200mA

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A2	CR8	1901–0033	DIODE SI 180V 200mA
A2	CR9	1901–0159	DIODE SI 400V .75A
A2	CR10	1901–0159	DIODE SI 400V .75A
A2	CR11	1901–0159	DIODE SI 400V .75A
A2	CR12	1901–0159	DIODE SI 400V .75A
A2	CR13	1901–0159	DIODE SI 400V .75A
A2	CR14	1901–0159	DIODE SI 400V .75A
A2	CR15	1901–0159	DIODE SI 400V .75A
A2	CR16	1901–0159	DIODE SI 400V .75A
A2	CR17	1901–0159	DIODE SI 400V .75A
A2	CR18	1901–0159	DIODE SI 400V .75A
A2	CR19	1901–0159	DIODE SI 400V .75A
A2	CR20	1901–0159	DIODE SI 400V .75A
A2	CR21	1902–3234	DIODE-Z 19.6V .4W
A2	CR101	1901–0376	DIODE SI 35V 2PF
A2	CR102	1901–0376	DIODE SI 35V 2PF
A2	CR104	1902–3048	DIODE-Z 3.48V +–5% .4W
A2	CR105	1902–3048	DIODE-Z 3.48V +–5% .4W
A2	CR106	1901–0358	DIODE SI DUAL MSD 6101
A2	CR110	1901–0040	DIODE SI 30V .05A
A2	CR111	1901–0358	DIODE SI DUAL MSD 6101
A2	CR112	1901–0358	DIODE SI DUAL MSD 6101
A2	CR113	1902–3048	DIODE-Z 3.48V +–5% .4W
A2	CR301	1901–0040	DIODE SI 30V .05A
A2	CR302	1901–0040	DIODE SI 30V .05A
A2	CR303	1901–0040	DIODE SI 30V .05A
A2	CR304	1901–0040	DIODE SI 30V .05A
A2	CR305	1901–0535	DIODE SI 15V .02A HOT
A2	CR306	1901–0535	DIODE SI 15V .02A HOT
A2	CR307	1902–3137	DIODE-Z 8.06V +–2% 0.4W
A2	CR308	1902–3036	DIODE-Z 3.16V +–5% 0.4W
A2	J8	1251–0213	SKT 15-PIN FOR PC
A2	J9	1251–0213	SKT 15-PIN FOR PC
A2	J11	1250–0518	CONNECTOR BNC
A2	J12	1250–0518	CONNECTOR BNC
A2	J13	1250–0518	CONNECTOR BNC
A2	MC1	1820–0439	IC-LIN VOLT REG UA7231C DIP
A2	MC2	1820–0196	IC VOLT REG UA723HO
A2	MC3	1826–0122	IC REGULATOR UA7805
A2	MC4	1820–0203	IC OP AMP UA741
A2	MP1	01220–00601	SHIELD ATTENUATOR (A105/205)
A2 A105	MP1	3130–0038	COUPLER-SWITCH
A2 A105	MP2	01220–00602	SHIELD
A2 A105	MP3	01220–00603	BRACKET
A2 A105	MP4	1251–0680	CONTACT STRIP
A2 A105	MP5	1251–0681	CONTACT STRIP
A2	Q1	1854–0330	TRANSISTOR SI NPN
A2	Q2	1854–0402	TRANSISTOR SI NPN
A2	Q3	1854–0402	TRANSISTOR SI NPN

REFERENCE DESGINATOR		HP PART NUMBER	DESCRIPTION
A2	Q4	1854–0071	TRANSISTOR SI NPN FT = 200 MHz
A2	Q101	1855–0202	TRANSISTOR J-FET DUAL SI N D-MODE
A2	Q103	1854–0215	TRANSISTOR NPN 2N3904
A2	Q104	1854–0215	TRANSISTOR NPN 2N3904
A2	Q107	5080–1081	TRANSISTOR SEL PAIR
A2	Q109	1853–0036	TRANSISTOR 2N3906 PNP
A2	Q110	1853–0036	TRANSISTOR 2N3906 PNP
A2	Q301	1853–0036	TRANSISTOR PNP 2N3906
A2	Q302	1853–0036	TRANSISTOR PNP 2N3906
A2	R1	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R2	0761–0069	R–F 5.1K +–5% 1W MO TUBULAR
A2	R3	0761–0069	R–F 5.1K +–5% 1W MO TUBULAR
A2	R4	0757–0384	R–F 20 +–1% 1/8W MET FLM
A2	R5	0757–0429	R–F 1.82 +–1% 1/8W MET FLM
A2	R6	0757–0465	R–F 100 +–1% 1/8W MET FLM
A2	R7	0757–0279	R–F 3.16K +–1% 1/8W MET FLM
A2	R8	0757–0279	R–F 3.16K +–1% 1/8W MET FLM
A2	R9	0757–0430	R–F 2.21K +–1% 1/8W MET FLM
A2	R10	2100–2795	R–VAR 470 1/2W CER MET
A2	R11	0757–0461	R–F 68.1K +–1% 1/8W MET FLM
A2	R12	0757–0449	R–F 20K +–1% 1/8W MET FLM
A2	R13	0757–0465	R–F 100K +–1% 1/8W MET FLM
A2	R14	0757–0442	R–F 10K +–1% 1/8W MET FLM
A2	R15	0757–0442	R–F 10K +–1% 1/8W MET FLM
A2	R16	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A2	R17	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A2	R18	0757–0407	R–F 200 +–1% 1/8W MET FLM
A2	R19	0698–6254	R–F 1.8 +–5% 1/2W CAR COMP
A2	R20	0698–6254	R–F 1.8 +–5% 1/2W CAR COMP
A2	R21	0698–0077	R–F 93.1K +–1% 1/8W MET FLM
A2	R22	0757–0438	R–F 5.11K +–1% 1/8W MET FLM
A2	R23	0757–0472	R–F 200K +–1% 1/8W MET FLM
A2 A105	R101	0757–0386	R–F 24.3 +–1% 1/8W MET FLM
A2	R102	0698–3431	R–F 23.7 +–1% 1/8W MET FLM
A2	R103	0757–0054	R–F 900K +–1% 1/2W MET FLM
A2	R104	0757–0057	R–F 990K +–1% 1/2W MET FLM
A2	R105	0698–5470	R–F 111K +–1% 1/8W MET FLM
A2	R106	0698–3109	R–F 10.1K +–1% 1/8W MET FLM
A2 A105	R107	0757–0393	R–F 47.5 +–1% 1/8W MET FLM
A2	R108	0757–0059	R–F 1M +–1% 1/2W MET FLM
A2	R109	0686–2245	R–F 220K +–5% 1/2W CAR COMP
A2	R111	0757–0401	R–F 100 +–1% 1/8W MET FLM
A2	R112	0757–0401	R–F 100 +–1% 1/8W MET FLM
A2	R113	0757–0124	R–F 39.2K +–1% 1/8W MET FLM
A2	R114	2100–2740	R–VAR 22K 1/2W CER MET
A2	R115	0757–0394	R–F 51.1 +–1% 1/8W MET FLM
A2	R116	0757–0394	R–F 51.1 +–1% 1/8W MET FLM
A2	R117	0698–0085	R–F 2.61K +–1% 1/8W MET FLM
A2	R118	0698–0085	R–F 2.61K +–1% 1/8W MET FLM
A2	R119	0757–0346	R–F 10 +–1% 1/8W MET FLM
A2	R120	0757–0346	R–F 10 +–1% 1/8W MET FLM

ɜembly A1—Trigger Board Assembly including TIME/DIV Switch Assembly A1A6

›mponents on sub—assembly A6 have the same numerical sequence as componets on assembly A1

EFERENCE)ESIGNATOR		HP PART NUMBER	DESCRIPTION
A1		01220—66501	BOARD ASSEMBLY TRIGGER (1220A)
A1		01221—66501	BOARD ASSEMBLY TRIGGER (1221A)
A1	A6	3100—0551	SWITCH ASSEMBLY TRIGGER
A1	C3	0160—2913	C—F 10NF —20 +85% 500WVDC CER
A1	C4	0160—3208	C—F 25NF —20 +80% 100WVDC CER
A1	C5	0160—3208	C—F 25NF —20 +80% 100WVDC CER
A1	C6	0170—0085	C—F 100NF +—20% 50VDC POLYE
A1	C7	0170—0085	C—F 100NF +—20% 50VDC POLYE
A1	C8	0170—0085	C—F 100NF +—20% 50VDC POLYE
A1	C10	0160—0174	C—F 470NF —20 +80% 25VDC CER
A1	C11	0180—0374	C—F 10UF +—10% 20VDC TAN
A1	C13	0160—2959	C—F 0.001UF —20+80% 1000WVDC CER
A1	C14	0180—0228	C—F 22UF +—10% 15VDC TAN SOLID
A1	C15	0160—2959	C—F 0.001UF —20 +80% 1000WVDC CER
A1	C17	0160—0938	C—F 1NF +—5% 100WVDC MICA (1220A)
A1	C18	0160—0938	C—F 1NF +—5% 100WVDC MICA (1220A)
A1	C19	0170—0085	C—F 100NF +—20% 50VDC POLYE
A1	C20	0170—0085	C—F 100NF +—20% 50VDC POLYE
A1	C21	0160—2204	C—F 100PF +—5% 300VDC MICA
A1	C22	0160—2204	C—F 100PF +—5% 300VDC MICA
A1	C23	0160—3208	C—F 25NF —20 +80% 100WVDC CER
A1	C24	0160—2261	C—F 15PF +—5% 500VDC CER
A1	C25	0160—2959	C—F 1UF —20 +80% 100VDC CER
A1	C26	0160—2959	C—F 1UF —20 +80% 1000WVDC CER
A1	C27	0180—0423	C—F 100UF —10 +100% 16VDC AL EL
A1	C28	0121—0476	C—VAR 5.5—65PF 100VDC POLYE
A1	C29	0140—0196	C—F 150PF +—5% 300VDC MICA
A1	C30	0160—3009	C—F 982PF +—1% 100VDC MICA
A1	C31	0160—3255	C—F 100NF +1% 250VDC POLYE
A1	C32	0160—0599	C—F 10UF +2% 63VDC MET POLYC
A1A6	C33	0160—2218	C—F 1NF +—5% 300VDC MIC
A1A6	C34	0160—3996	C—F 27NF +-10% 250WVDC
A1A6	C35	0180—1745	C—F 1.5UF +—10% 20VDC TAN EL
A1A6	C36	0180—0229	C—F 33UF +—10% 10VDC TAN EL
A1	C37	0160—0174	C—F 470NF —20 +80% 25VDC CER
A1	C38	0160—0174	C—F 37NF —20 +80% 25VDC CER
A1	C40	0160—3208	C—F 25NF —20 +80% 100VDC CER
A1	C43	0160—2959	C—F 1NF —20 +80% 1000WVDC CER
A1	C45	0160—2208	C—F 330PF +—5% 300VDC MICA (1220A)
A1	C46	0170—0085	C—F 100NF +—20% 50VDC POLYE
A1	C47	0160—2959	C—F 1UF —20 +80% 1000WVDC CER
A1	C401	0160—3208	C—F 25NF —20 +80% 100WVDC CER
A1	C402	0160—3208	C—F 25NF —20 +80% 100VDC CER
A1	C403	0160—2251	C—F 5.6PF +—0.25PF 500VDC CER
A1	C404	0160—2251	C—F 5.6PF +—0.25PF 500VDC CER
A1	C405	0160—2930	C—F 10NF —20 +80% 100VDC CER
A1	C406	0160—2930	C—F 10NF —20 +80% 100VDC CER
A1	C407	0160—2917	C—F 50NF —20 +80% 100VDC CER
A1	C408	0160—2930	C—F 10NF —20 +80% 100VDC CER
A1	C409	0160—2930	C—F 10NF —20 +80% 100VDC CER

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A1	C410	0170—0085	C—F 100NF +—20% 50WVDC POLYE
A1	C411	0170—0085	C—F 100NF +—20% 50WVDC POLYE
A1	CR1	1901—0376	DIODE SI 35V 2PF
A1	CR2	1901—0040	DIODE SI 30V .05A
A1	CR3	1910—0034	DIODE GE 30V 80MA (1220A)
A1	CR4	1910—0034	DIODE GE 30V 80MA
A1	CR5	1910—0034	DIODE GE 30V 80MA
A1	CR6	1902—3092	DIODE—Z 4.99V +—2% 400MV
A1	CR7	1902—3092	DIODE—Z 4.99V +—2% 400MV
A1	CR8	1901—0040	DIODE SI 30V .05A
A1	CR9	1901—0040	DIODE SI 30V .05A
A1	CR10	1901—0040	DIODE SI 30V .05A
A1	CR11	1902—3125	DIODE—Z 6.98V +—5% .4W
A1	CR12	1901—0040	DIODE SI 30V .05A
A1	CR13	1902—3125	DIODE—Z 6.98V +—5% .4W
A1	CR14	1910—0034	DIODE GE 30V 80MA
A1	CR15	1901—0040	DIODE SI 30V .05A
A1	CR16	1910—0034	DIODE GE 30V 80MA
A1	J6	1251—0567	SKT 8-PIN FOR PC
A1	J10	1251—0566	SKT 4-PIN FOR PC
A1	MC1	1820—0424	IC SN 74H04N
A1	MC2	1820—0054	IC SN 7400N
A1	MC3	1820—0054	IC SN 7400N
A1	MC4	1820—0370	IC SN 4478
A1	MC5	1820—0715	IC SN 74H106N
A1	MC6	1820—0704	IC SN74122N
A1	MC7	1820—0537	IC SN7413N
A1	MC8	1820—0596	IC DM 74L74N
A1	MP1	01220—43202	COUPLER SWITCH
A1A6	MP1	3130—0038	COUPLER-SWITCH
A1A6	MP2	1251—0683	CONTACT STRIP
A1A6	MP3	1251—0700	CONN STRIP—7CONT
A1	Q1	1855—0201	TRANSISTOR J—FET SI NWN485
A1	Q2	1853—0036	TRANSISTOR SI PNP 2N3906
A1	Q3	1854—0071	TRANSISTOR SI NPN
A1	Q4	1853—0034	TRANSISTOR SI PNP
A1	Q5	1853—0034	TRANSISTOR SI PNP
A1	Q6	1854—0071	TRANSISTOR SI NPN
A1	Q7	1854—0296	TRANSISTOR SI NPN
A1	Q8	1853—0015	TRANSISTOR SI PNP 2N3640
A1	Q9	1854—0071	TRANSISTOR SI NPN
A1	Q10	1854—0071	TRANSISTOR SI NPN
A1	Q11	1853—0086	TRANSISTOR SI PNP 2N5087
A1	Q12	1854—0005	TRANSISTOR SI NPN 2N708
A1	Q13	1854—0392	TRANSISTOR SI NPN 2N5088
A1	Q14	1854—0071	TRANSISTOR SI NPN
A1	Q15	1853—0218	TRANSISTOR SI PNP

Table 5–3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A1	Q16	1853–0218	TRANSISTOR SI PNP
A1	Q17	1854–0071	TRANSISTOR SI NPN
A1	Q18	1854–0071	TRANSISTOR SI NPN
A1	Q19	1854–0621	TRANSISTOR SI NPN BF258
A1	Q20	1854–0621	TRANSISTOR SI NPN BF258
A1	Q21	1853–0355	TRANSISTOR SI PNP BF398
A1	Q22	1853–0355	TRANSISTOR SI PNP BF398
A1	Q23	1853–0355	TRANSISTOR SI PNP BF398
A1	Q24	1853–0355	TRANSISTOR SI PNP BF398
A1	Q401	1853–0314	TRANSISTOR SI PNP 2N9505A
A1	Q402	1853–0314	TRANSISTOR SI PNP 2N9505A
A1	Q403	1853–0314	TRANSISTOR SI PNP 2N9505A
A1	Q404	1853–0314	TRANSISTOR SI PNP 2N9505A
A1	Q405	1854–0637	TRANSISTOR SI PNP 2N2219
A1	Q406	1854–0637	TRANSISTOR SI PNP 2N2219
A1	Q407	1854–0637	TRANSISTOR SI PNP 2N2219
A1	Q408	1854–0637	TRANSISTOR SI PNP 2N2219
A1	Q409	1853–0218	TRANSISTOR SI PNP
A1	Q410	1853–0218	TRANSISTOR SI PNP
A1	Q411	1854–0019	TRANSISTOR SI NPN
A1	Q412	1854–0019	TRANSISTOR SI NPN
A1	R1	0757–0416	R–F 511 +–1% 1/8W MET FLM
A1	R2	0757–0346	R–F 10 +–1% 1/8W
A1	R3	0757–0438	R–F 5.11K +–1% 1/8W MET FLM
A1	R4	0757–0475	R–F 274K +–1% 1/8W MET FLM
A1	R5	0757–0288	R–F 9.09K +–1% 1/8W MET FLM
A1	R6	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R7	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R8	0757–0283	R–F 2K +–1% 1/8W MET FLM
A1	R9	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R10	0757–0419	R–F 681 +–1% 1/8W MET FLM
A1	R11	0698–3150	R–F 2.37K +–1% 1/8W MET FLM
A1	R12	0757–0274	R–F 1.21K +–1% 1/8W MET FLM
A1	R13	0757–0415	R–F 475 +–1% 1/8W MET FLM
A1	R14	0698–4453	R–F 402 +–1% 1/8W MET FLM
A1	R15	0698–3150	R–F 2.37K +–1% 1/8W MET FLM
A1	R16	0757–0274	R–F 1.21K +–1% 1/8W MET FLM
A1	R17	0698–4453	R–F 402 +–1% 1/8W MET FLM
A1	R18	0698–3540	R–F 15.4K +–1% 1/8W MET FLM
A1	R19	0757–0431	R–F 2.43K +–1% 1/8W MET FLM
A1	R20	0757–0274	R–F 1.21K +–1% 1/8W MET FLM
A1	R21	0757–0416	R–F 511 +–1% 1/8W MET FLM(1220A)
A1	R22	0757–0394	R–F 51.1 +–1% 1/8W MET FLM
A1	R23	0757–0280	R–F 1K +–1% 1/8W MET FLM (1220A)
A1	R24	0698–4439	R–F 3.24K +–1% 1/8W MET FLM
A1	R25	0698–4439	R–F 3.24K +–1% 1/8W MET FLM
A1	R26	0757–0424	R–F 1M +–5% 1/4W CAR COMP
A1	R27	0757–0440	R–F 7.5K +–1% 1/8W MET FLM
A1	R29	0683–1055	R–F 1M 5% +–5% 1/4W CAR COMP
A1	R30	0757–0444	R–F 12.1K +–1% 1/8W MET FLM
A1	R31	0757–0449	R–F 20K +–1% 1/8W MET FLM
A1	R32	0698–4496	R–F 45.3K +–1% 1/8W MET FLM
A1	R33	0698–4495	R–F 37.4K +–1% 1/8W MET FLM
A1	R34	0757–0468	R–F 130K +–1% 1/8W MET FLM

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A1	R35	0757–0459	R–F 56.2K +–1% 1/8W MET FLM
A1	R36	0757–0449	R–F 20K +–1% 1/8W MET FLM
A1	R37	0757–0457	R–F 47.5K +–1% 1/8W MET FLM
A1	R38	0757–0465	R–F 100K +–1% 1/8W MET FLM
A1	R39	0757–0457	R–F 47.5K +–1% 1/8W MET FLM
A1	R40	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1	R41	0757–0283	R–F 2K +–1% 1/8W MET FLM
A1	R42	0757–0438	R–F 5.11K +–1% 1/8W MET FLM
A1	R43	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R44	0758–0006	R–F 10K +–5% 1/4W MET FLM
A1	R45	0757–0394	R–F 51.1 +–1% 1/8W MET FLM
A1	R46	0757–0420	R–F 750 +–1% 1/8W MET FLM
A1	R47	0757–0401	R–F 100 +–1% 1/8W MET FLM
A1	R48	0757–0407	R–F 200 +–1% 1/8WMET FLM
A1	R49	0757–0453	R–F 30.1K +–1% 1/8W MET FLM
A1	R50	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A1	R51	0757–0430	R–F 2.21K +–1% 1/8W MET FLM
A1	R52	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1	R53	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1	R54	0757–0283	R–F 2K +–1% 1/8W MET FLM (1220A)
A1	R55	0757–0283	R–F 2K +–1% 1/8W MET FLM (1220A)
A1	R56	0757–0431	R–F 2.43K +–1% 1/8W MET FLM
A1	R57	0757–0431	R–F 2.43K +–1% 1/8W MET FLM
A1	R58	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1	R59	0757–0280	R–F 1K +–1% 1/8W MET FLM
A1	R60	0698–4471	R–F 7.15K +–1% 1/4W MET FLM
A1	R61	0698–4471	R–F 7.15K +–1% 1/4W MET FLM
A1	R62	0757–0407	R–F 200 +–1% 1/8W MET FLM
A1	R63	0698–4495	R–F 37.4K +–1% 1/8W MET FLM
A1	R64	0757–0454	R–F 33.2K +–1% 1/8W MET FLM
A1	R65	0698–4495	R–F 37.4K +–1% 1/8W MET FLM
A1	R66	2100–2786	R–VAR 100 +–20% 1/2W
A1A6	R67	0757–0424	R–F 1.1K +–1% 1/8W MET FLM
A1A6	R68	0757–0200	R–F 5.62K +–1% 1/8W MET FLM
A1	R69	0698–3225	R–F 1.43K +–1% 1/8W MET FLM
A1	R70	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R71	0698–3225	R–F 1.43K +–1% 1/8W MET FLM
A1	R72	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R73	0757–0416	R–F 511 +–1% 1/8W MET FLM
A1	R74	0757–0416	R–F 511 +–1% 1/8W MET FLM
A1	R75	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R76	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R77	0757–0044	R–F 33.2K +–1% 1/8W MET FLM
A1	R78	0757–0044	R–F 33.2K +–1% 1/8W MET FLM
A1	R79	0761–0028	R–F 12K +–5% IW MET FLM
A1	R80	0761–0028	R–F 12K +–5% IW MET FLM
A1	R81	0761–0028	R–F 12K +–5% IW MET FLM
A1	R82	0761–0028	R–F 12K +–5% IW MET FLM
A1	R83	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R84	0757–0399	R–F 82.5 +–1% 1/8W MET FLM
A1	R85	0757–0469	R–F 150K +–1% 1/8W MET FLM

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A2	R121	0757–0273	R–F 3.01K +–1% 1/8W MET FLM
A2	R122	0757–0273	R–F 3.01K +–1% 1/8W MET FLM
A2	R123	0757–0420	R–F 750 +–1% 1/8W MET FLM
A2	R124	0757–0420	R–F 750 +–1% 1/8W MET FLM
A2	R125	0698–4384	R–F 54.9 +–1% 1/8W MET FLM
A2	R126	0698–4384	R–F 54.9 +–1% 1/8W MET FLM
A2	R127	0757–0407	R–F 200 +–1% 1/8W MET FLM
A2	R128	0757–0407	R–F 200 +–1% 1/8W MET FLM
A2	R129	0757–0419	R–F 681 +–1% 1/8W MET FLM
A2	R130	0757–0465	R–F 100K +–1% 1/8W MET FLM
A2	R131	0757–0465	R–F 100K +–1% 1/8W MET FLM
A2	R132	0757–0346	R–F 10 +–1% 1/8W MET FLM
A2	R133	0757–0346	R–F 10 +–1% 1/8W MET FLM
A2	R135	0757–0437	R–F 4.75K +–1% 1/8W MET FLM
A2	R136	0757–0437	R–F 4.75K +–1% 1/8W MET FLM
A2	R138	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R139	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R140	0757–0317	R–F 1.33K +–1% 1/8W MET FLM
A2	R141	0757–0317	R–F 1.33K +–1% 1/8W MET FLM
A2	R142	0698–3268	R–F 11.5K +–1% 1/8W MET FLM
A2	R143	0757–0454	R–F 33.2K +–1% 1/8W MET FLM
A2	R144	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R145	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R146	0698–3447	R–F 422 +–1% 1/8W MET FLM
A2	R147	0757–0410	R–F 301 +–1% 1/8W MET FLM
A2	R148	2100–2740	R–VAR 22K 1/2W CER MET
A2A105	R149	2100–0590	R–VAR 500 10% LIN
A2	R150	0698–3510	R–F 453 +–1% 1/8W
A2	R151	0757–0273	R–F 3.01K +–1% 1/8W MET FLM
A2	R152	0757–0273	R–F 3.01K +–1% 1/8W MET FLM
A2	R153	0698–3510	R–F 453 +–1% 1/8W
A2	R154	0757–0273	R–F 3.01K +–1% 1/8W MET FLM
A2	R155	0757–0273	R–F 3.01K +–1% 1/8W MET FLM
A2A105	R159	2100–0593	R–VAR 10K 20% LIN (1220A)
A2	R160	0757–0434	R–F 3.65K +–1% 1/8W MET FLM
A2	R162	2100–2797	R–VAR 4.7K 1/2W CER MET
A2	R163	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R165	0698–3530	R–F 470 +–5% 1/8W MET FLM
A2	R166	0698–3530	R–F 470 +–5% 1/8W MET FLM
A2	R167	0698–3252	R–F 450 +–1% 1/8W MET FLM
A2	R168	0698–3252	R–F 450 +–1% 1/8W MET FLM
A2	R169	0698–4402	R–F 97.6 +–1% 1/8W MET FLM
A2	R170	0698–4402	R–F 97.6 +–1% 1/8W MET FLM
A2	R171	0698–3447	R–F 422 +–1% 1/8W MET FLM
A2	R172	0698–3447	R–F 422 +–1% 1/8W MET FLM
A2	R173	0757–0407	R–F 200 +–1% 1/8W MET FLM
A2	R174	0757–0442	R–F 10K +–1% 1/8W MET FLM
A2	R175	2100–2740	R–VAR 22K 1/2W CER MET
A2	R176	0757–0465	R–F 100K +–1% 1/8W MET FLM

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A2	R177	0757–0465	R–F 100K +–1% 1/8W MET FLM
A2	R178	0757–0465	R–F 100K +–1% 1/8W MET FLM
A2	R179	0757–0449	R–F 20K +–1% 1/8W MET FLM
A2	R180	0757–0346	R–F 10 +–1% 1/8W MET FLM
A2	R181	0757–0346	R–F 10 +–1% 1/8W MET FLM
A2	R182	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A2	R183	0757–0427	R–F 1.5K +–1% 1/8W MET FLM
A2	R184	0757–0407	R–F 200 +–1% 1/8W MET FLM
A2	R185	0757–0407	R–F 200 +–1% 1/8W MET FLM
A2	R301	0757–0421	R–F 825 +–1% 1/8W MET FLM
A2	R302	0757–0437	R–F 4.75K +–1% 1/8W MET FLM
A2	R303	0757–0280	R–F 1K +–1% 1/8W MET FLM
A2	R304	0757–0453	R–F 30.1K +–1% 1/8W MET FLM
A2	R305	0757–0420	R–F 750 +–1% 1/8W MET FLM
A2	R306	0757–0384	R–F 20 +–1% 1/8W MET FLM
A2	R307	0757–0384	R–F 20 +–1% 1/8W MET FLM
A2	R308	0698–3262	R–F 40.2 +–1% 1/8W MET FLM
A2	R309	0698–3262	R–F 40.2 +–1% 1/8W MET FLM
A2	R310	0757–0417	R–F 562 +–1% 1/8W MET FLM
A2	R311	0698–3151	R–F 2.87K +–1% 1/8W MET FLM
A2	R312	0698–3151	R–F 2.87K +–1% 1/8W MET FLM
A2	R313	0698–3151	R–F 2.87K +–1% 1/8W MET FLM
A2	R314	0698–4435	R–F 2.49K +–1% 1/8W MET FLM
A2	R315	0757–0384	R–F 20 +–1% 1/8W MET FLM
A2	R601	0757–0054	R–F 900K +–1% 1/2W MET FLM
A2	R602	0757–0465	R–F 100K +–1% 1/8W MET FLM
A2	R603	0757–0401	R–F 100 +–1% 1/8W MET FLM
A2	S4	3101–0560	SWITCH-PUSHBUTTON
A2	U101	1821–0001	TRANSISTOR ARRAY CA3046
A2	U102	1821–0001	TRANSISTOR ARRAY CA3046
A2	U301	1821–0001	TRANSISTOR ARRAY CA3046

Table 5–3. Replaceable Parts (cont'd)

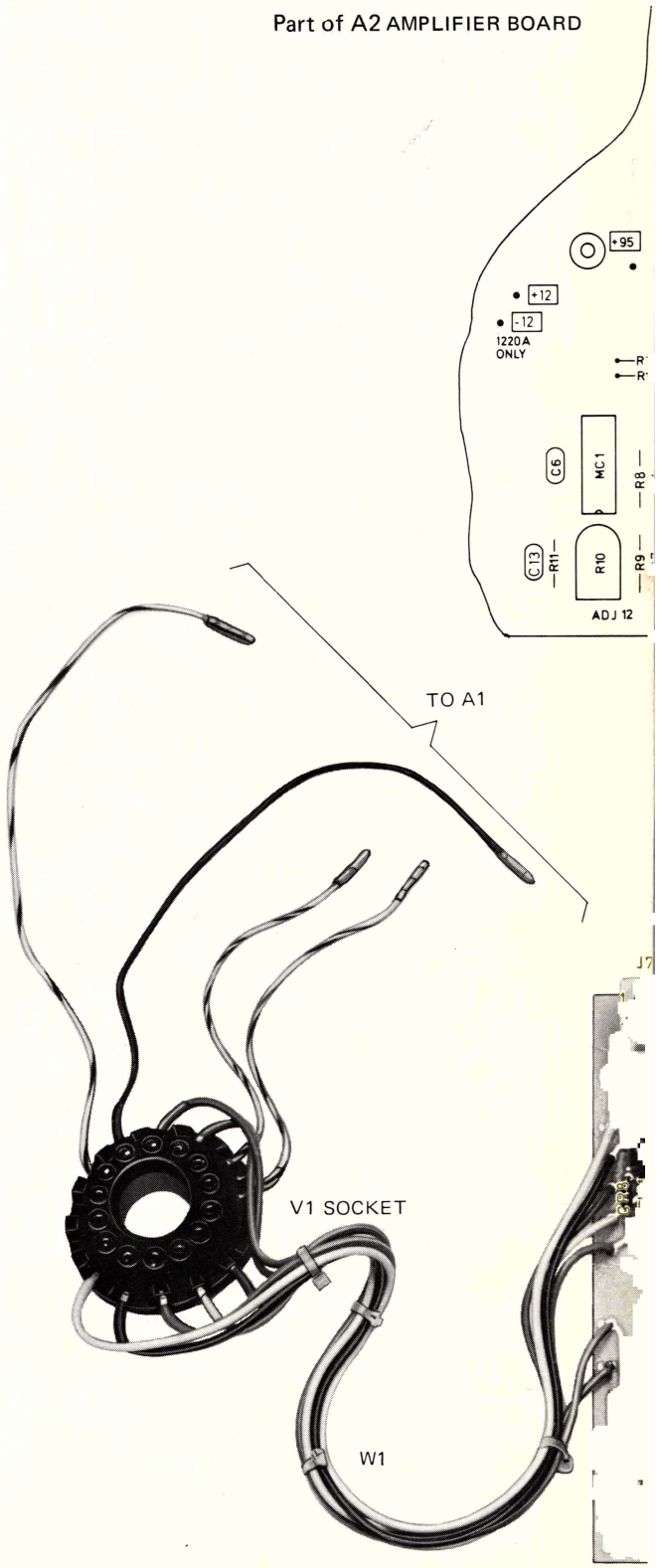
Assembly A3–High Voltage Board

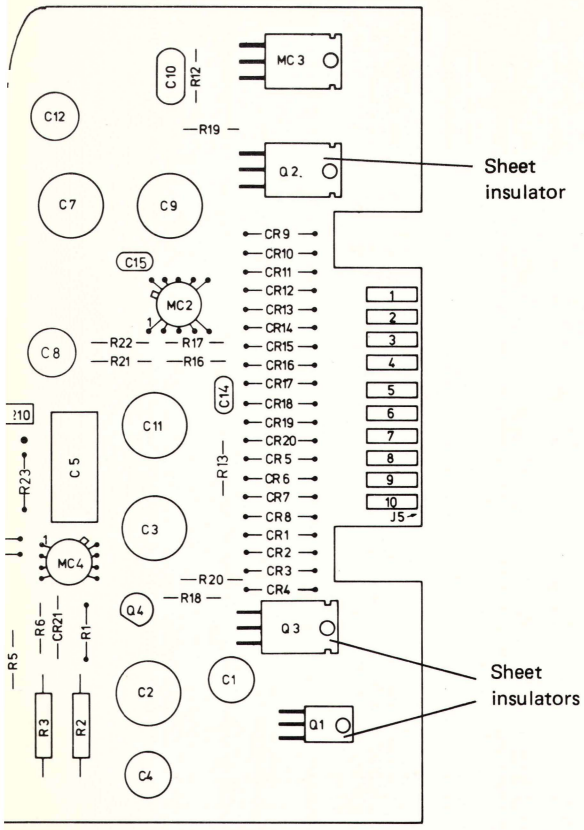
REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A3		01220–66507	BD AY HIGH VOLTAGE
A3	C1	0160–4044	C–F 220NF +–20% 300V DC POLYE
A3	C2	0160–2930	C–F 10NF +80 –20% 100WVDC CERA
A3	C3	0160–2913	C–F 10NF +85 –20% 500VDC CERA
A3	C4	0160–4042	C–F 15NF +–20% 300 VDC POLYE
A3	C5	0160–3720	C–F 100NF +–10% 16VDC MET POLYC
A3	C6	0160–4042	C–F 15NF +–20% 3000VDC POLYE
A3	C7	0160–3208	C–F 25NF +80 –20% 100VDC CER
A3	C8	0160–3208	C–F 25NF +80 –20% 100VDC CER
A3	C9	0160–2930	C–F 10NF +80 –20% 100VDC CER
A3	C11	0170–0085	C–F .1UF +–20% 50V POLYE
A3	C12	0160–2902	C–F 10NF +–20% 500VDC CER
A3	C13	0170–0085	C–F .1UF +–20% 50V POLYE
A3	C15	0160–0151	C–F 4.7NF +80 –20% 4000WVDC
A3	C18	0160–2959	C–F 1NF –20 +80% 1KWVDC CER
A3	CR1	1902–3290	DIODE-Z 31.6V 5% 0.4W
A3	CR2	1902–0586	DIODE-Z 150V 5% 1.0W
A3	CR3	1902–0586	DIODE-Z 150V 5% 1.0W
A3	CR4	1902–0586	DIODE-Z 150V 5% 1.0W
A3	CR5	1901–0050	DIODE SI 30V 50mA
A3	CR6	1901–0050	DIODE SI 30V 50mA
A3	CR7	1901–0050	DIODE SI 30V 50mA
A3	CR8	1901–0586	DIODE SI 1N4007
A3	CR9	1901–0050	DIODE SI 30V 50mA
A3	CR10	1901–3082	DIODE-Z 4.64V 5% 0.4W
A3	CR11	1902–0243	DIODE-Z 30.1V 5% 0.4W
A3	CR12	1902–3304	DIODE-Z 35.7V .4W
A3	CR13	1902–3357	DIODE-Z 56.2V .4W
A3	CR14	1901–0489	DIODE SI 2.5KV .25A
A3	CR15	1901–0489	DIODE SI 2.5KV .25A
A3	CR16	1901–0489	DIODE SI 2.5KV .25A
A3	CR17	1901–0489	DIODE SI 2.5KV .25A
A3	CR18	1901–0033	DIODE SI 1N485B
A3	CR19	1901–0050	DIODE SI
A3	J7	1251–2496	BODY R&P 5 CONNECTOR
A3	MC1	1820–0203	IC OP AMP UA741
A3	MP1	1251–0571	CONNECTOR
A3	Q1	1854–0622	TRANSISTOR SI NPN
A3	Q2	1853–0036	TRANSISTOR SI PNP 2N3906
A3	Q4	1854–0215	TRANSISTOR SI NPN 2N3904

REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A3	R1	2100–2784	R–VAR 470K 20% 0.5W LIN
A3	R2	2100–2782	R–VAR 100K 20% 0.5W LIN
A3	R3	2100–2789	R–VAR 10K 20% .5W LIN
A3	R4	2100–2782	R–VAR 100K 20% 0.5W LIN
A3	R5	2100–0594	R–VAR 5M 30% 2W LIN CF
A3	R6	2100–0595	R–VAR 2.5M 30% 2W LIN CF
A3	R7	0757–0280	R–F 1K 1% .125W F MET FLM
A3	R8	0757–0416	R–F 511 1% .125W MET FLM
A3	R9	0757–0468	R–F 130K 1% .125W MET FLM
A3	R10	0698–3452	R–F 147K 1% .125W MET FLM
A3	R11	0757–0052	R–F 500K 1% 1/2W MET FLM
A3	R12	0757–0052	R–F 500K 1% 1/2W MET FLM
A3	R13	0757–0052	R–F 500K 1% 1/2W MET FLM
A3	R14	0757–0052	R–F 500K 1% 1/2W MET FLM
A3	R15	0757–0052	R–F 500K 1% 1/2W MET FLM
A3	R16	0698–3455	R–F 261K 1% 1/8W MET FLM
A3	R17	0698–5038	R–F 560K 1% 1/2W MET FLM
A3	R18	0698–4522	R–F 165K 1% 1/8W MET FLM
A3	R19	0690–1061	R–F 10M 10% 1W CAR COMP
A3	R20	0757–0394	R–F 51.1 1% 1/8W MET FLM
A3	R21	0683–2265	R–F 22M 5% 1/4W CAR COMP
A3	R22	0757–0346	R–F 10 1% 1/8W MET FLM
A3	R23	0757–0403	R–F 121 1% 1/8W MET FLM
A3	R24	0757–0449	R–F 20K 1% 1/8W MET FLM
A3	R25	0757–0442	R–F 10K 1% 1/8W MET FLM
A3	R26	0757–0449	R–F 20K 1% 1/8W MET FLM
A3	R27	0757–0433	R–F 3.32K 1% MET FLM
A3	R28	0698–3495	R–F 866 1% 1/8W MET FLM
A3	R29	0757–0433	R–F 3.32K 1% MET FLM
A3	R30	2100–2740	R–VAR 22K 20% 0.5W LIN CF
A3	R31	0758–0057	R–F 5.6K 5%, 1/2W
A3	R32	0757–0384	R–F 20 1%
A3	R33	0686–1025	R–F 1K 5% 1/2W
A3	R34	0686–1015	R–F 100 5%
A3	R35	0686–4735	R–F 47K 5% 1/2W
A3	R36	0686–4735	R–F 47K 5% 1/2W
A3	R37	0757–0457	R–F 47,5K 1%
A3	S6	3101–1734	SWITCH ASSY
A3	W1	01220–61601	CABLE
A3	W2	01220–61602	CABLE

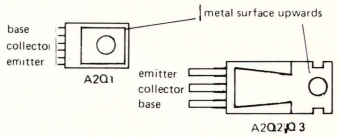
Assembly A4—Heat Sink Assembly

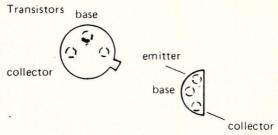
REFERENCE DESIGNATOR		HP PART NUMBER	DESCRIPTION
A4		01220–61101	HEAT SINK ASSEMBLY
A4	C1	0160–4026	C–F .2UF 20% 25WDC
A4	F1	1400–0084	FUSE HOLDER
A4	J1	1251–2357	CONN PWR AC RECEPTACLE
A4	J2	1251–0406	JACK TELE 2
A4	J3	1251–0229	BODY BANANA
A4	J4	1510–0038	BDG POST .812 LG
A4	MP1	01220–44102	COVER POWER SWITCH
A4	MP2	01220–47403	PUSH BUTTON SHRR
A4	S1	3101–0555	SW LINE, 1 STAT
A4	S5	3101–1609	SW DPDT, DUAL
A4	T1	01220–61103	TRANSFORMER ASSEMBLY
A4	X1	1251–0166	CONN-PC 10CONT
A4	X2	1251–2495	CONN (PART OF T1 ASSEMBLY)
A4	X3	1251–2990	CONT R&P CONN

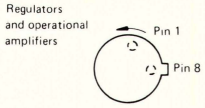


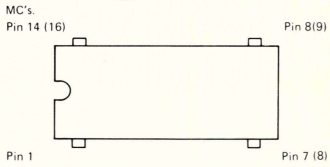


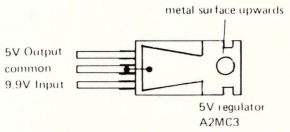
COMPONETS ARE AS SEEN FROM TOP, ◯ REPRESENTS LOCATION OF PIN ON OTHER SIDE





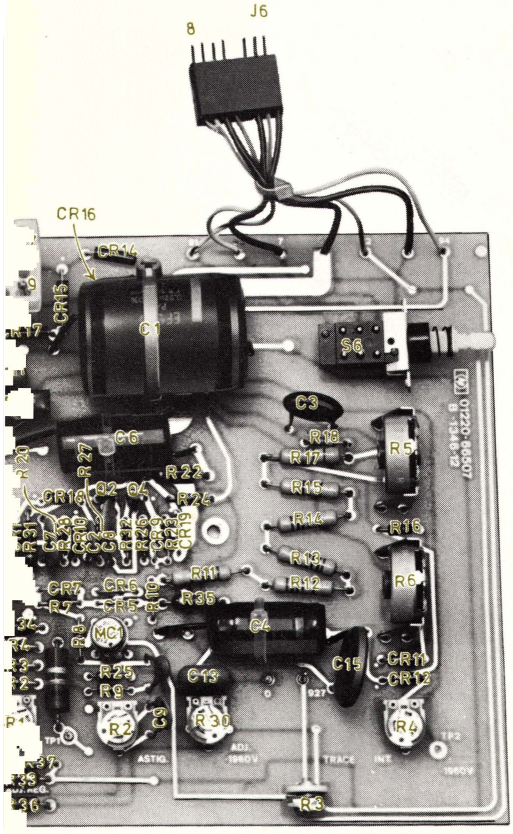


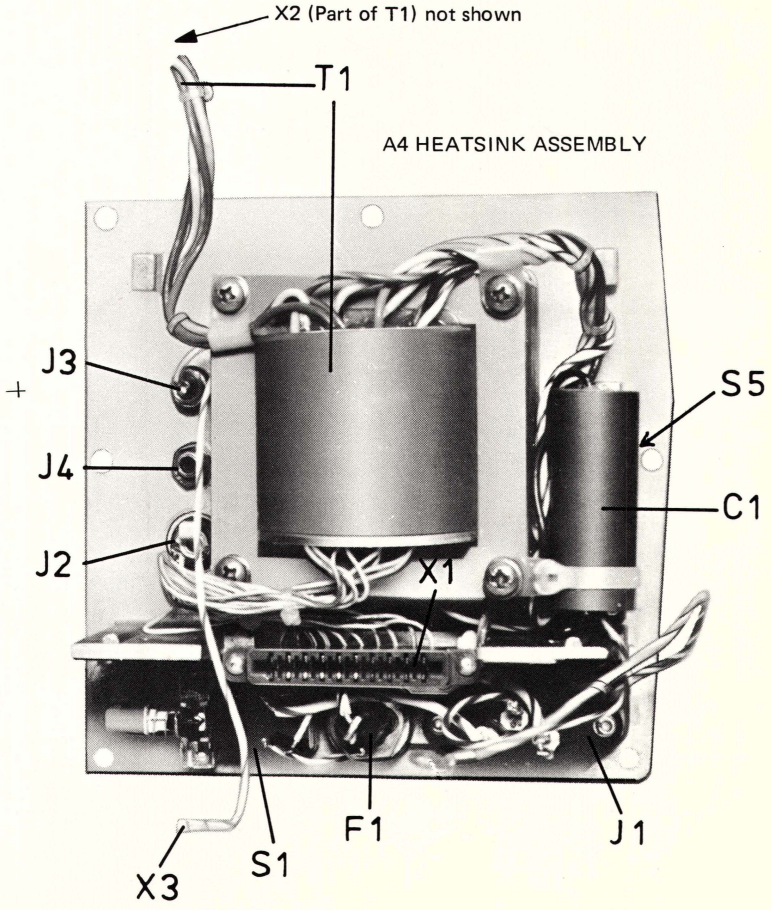


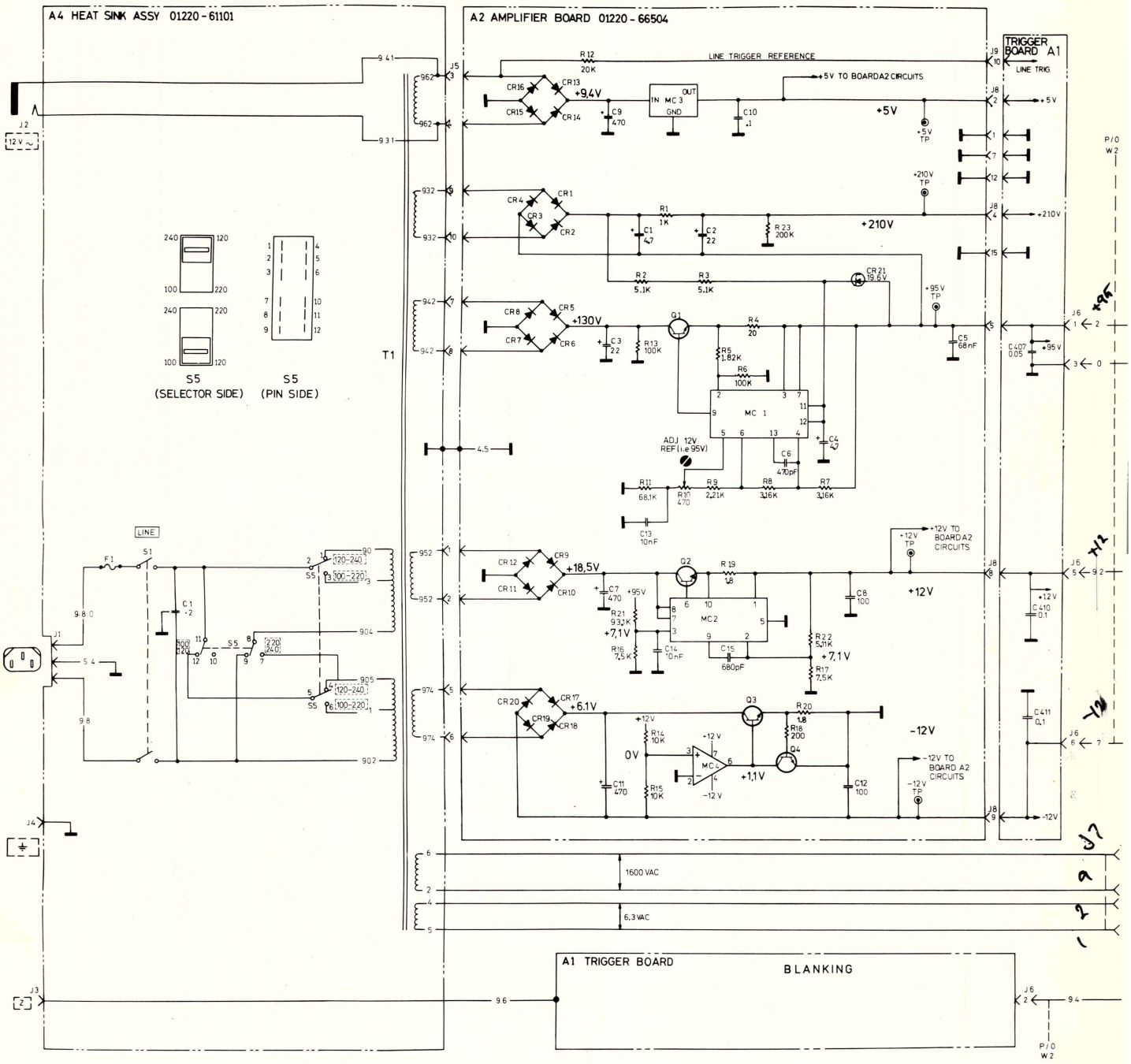


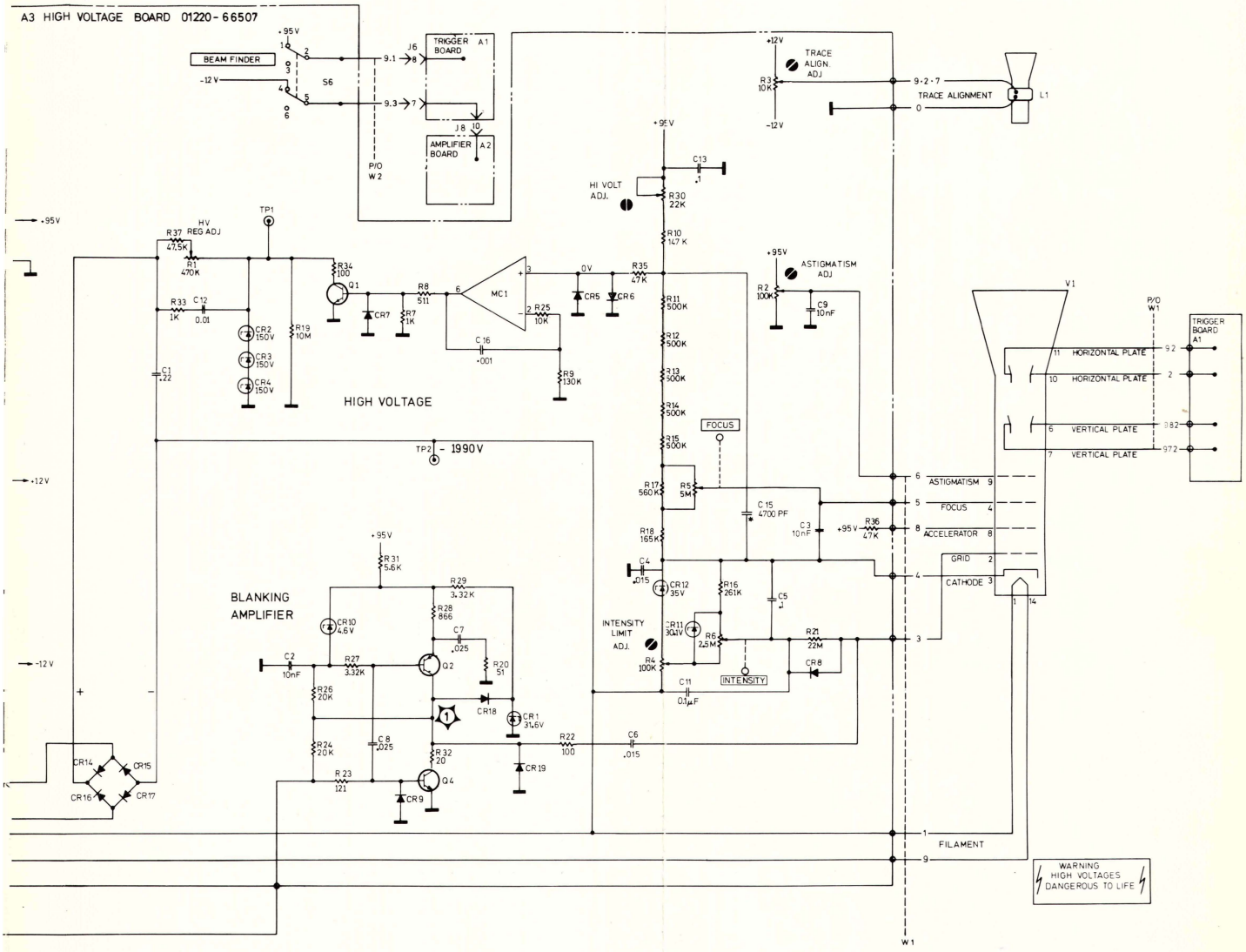
NOTE: Sheet insulators are fixed to power transistors, and power transistors to board, with a cyanoacrylate adhesive. Do not use ordinary adhesive; if too thick a layer is produced, heat dissipation is adversely affected.

A3 HIGH VOLTAGE BOARD

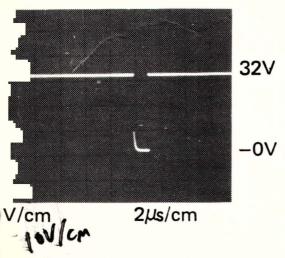




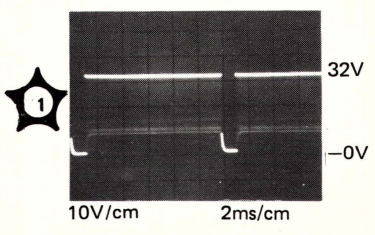

A4 HEAT SINK ASSY 01220-61101
A2 AMPLIFIER BOARD 01220-66504
TRIGGER BOARD A1
LINE TRIGGER REFERENCE
+5V TO BOARD A2 CIRCUITS
LINE TRIG.
+9,4V
+5V
+210V
+130V
+18,5V
+6,1V
-12V
+7,1V
+1,1V
0V
+12V TO BOARD A2 CIRCUITS
-12V TO BOARD A2 CIRCUITS
ADJ 12V REF (i.e 95V)
MC 1
MC 2
MC 4
T1
S5 (SELECTOR SIDE)
S5 (PIN SIDE)
LINE
1600 VAC
6,3 VAC
A1 TRIGGER BOARD
BLANKING



Retrace blanking
(single channel mode)



Retrace and chop blanking
(chop mode, 1220A only)



Retrace and chop blanking expanded
to show individual chop blanking pulses

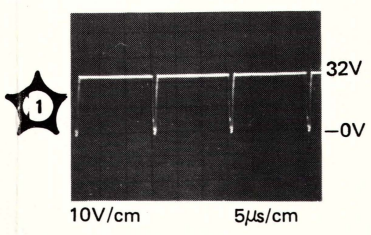
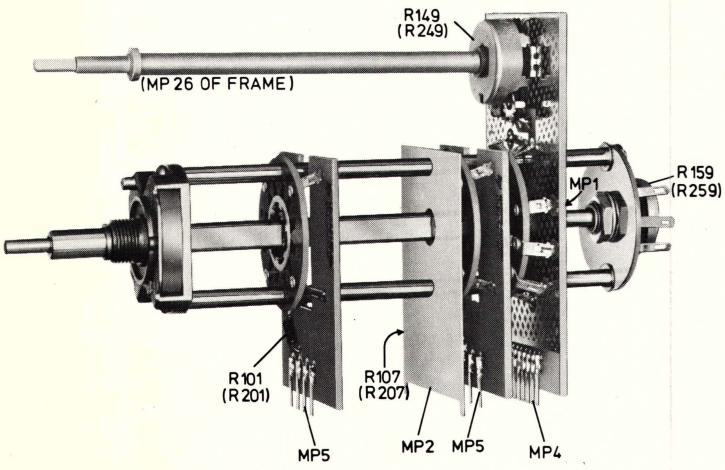


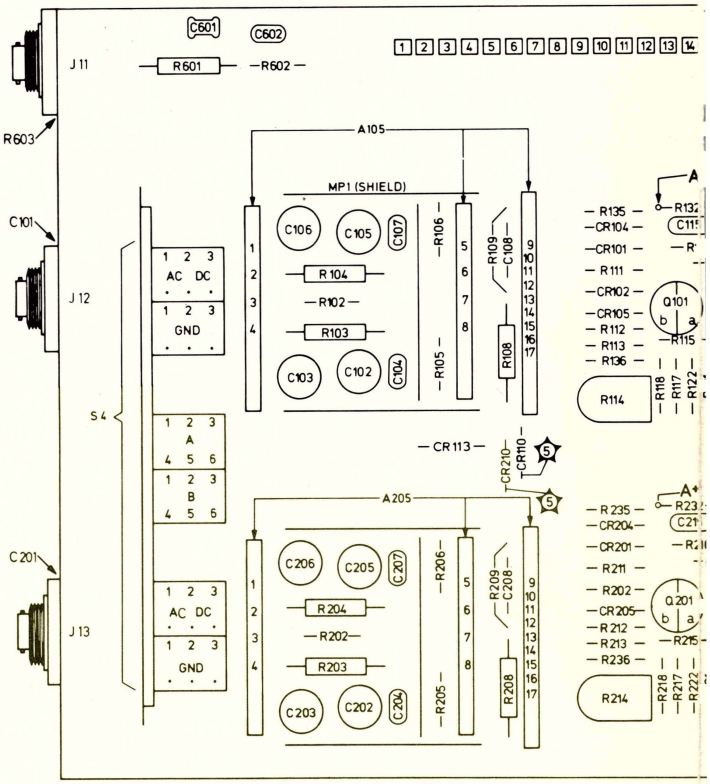
Figure 5–2. Power Supplies. (Assemblies A3, A4 and part A2)

A2 A105 (205) VOLTS/DIV SWITCH ASSEMBLY



COMPONENTS AS SEEN FROM TOP. ⌀ Represents location of pin

A2 AMPLIFIER BOARD

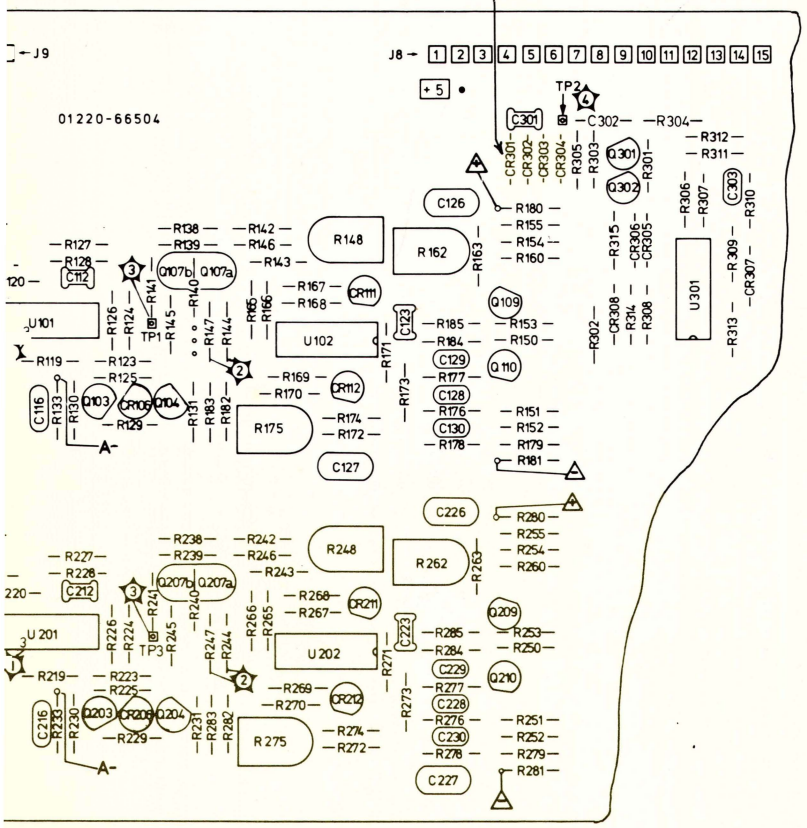


R101, 103, 104, 105, 106, 108, 109, 202, 203, 204, 205, 206, 208, 209, 601, 602, 603.
C101, 102, 103, 104, 105, 106, 107, 108, 201, 202, 203, 204, 205, 206, 207, 208, 601, 602.
CR110, 113, 210.

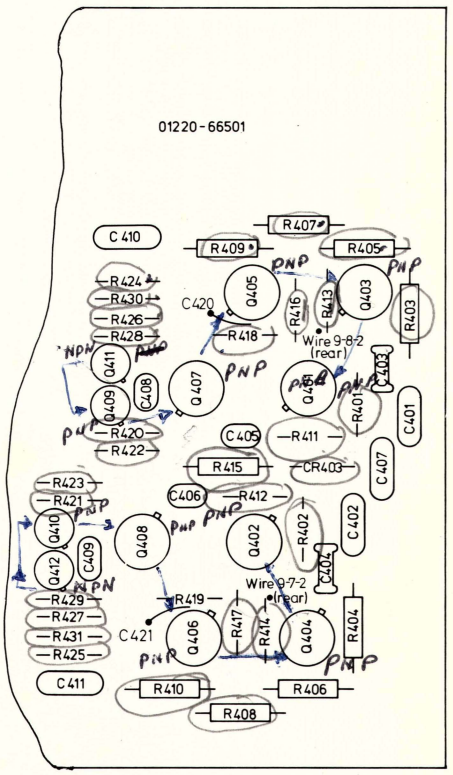
R111, 112, 113, 114, 1
120, 121, 122, 123, 1
129, 130, 131, 133, 1
211, 212, 213, 214, 2
220, 221, 222, 223, 2
229, 230, 232, 233, 2
C11, 115, 116, 212, 2
CR101, 102, 104, 105.
Q101, 201.
U101, 201.

n other side

CR301 replaced by wire link in 1221A



PART OF A1 TRIGGER BOARD

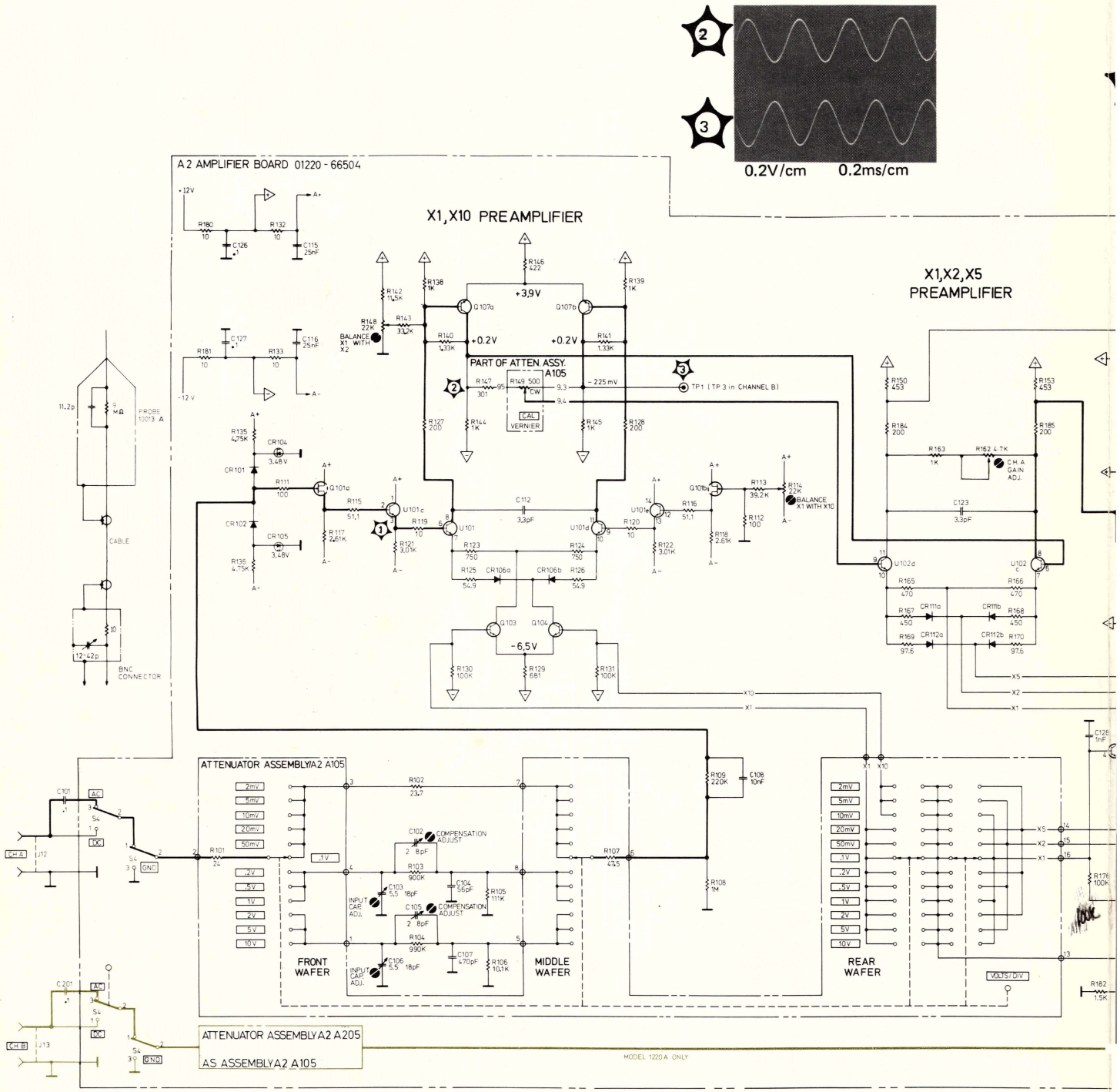


, 116, 117, 118, 119 , 125, 126, 127, 128, 135, 136, 141, 202, 216, 217, 218, 219, 225, 226, 227, 228, 235, 236, 241.
216,
06, 201, 204, 205,206

R131, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 162, 163, 165, 166, 167, 168, 169, 170, 172, 173, 174, 175, 176, 177, 178, 182, 183, 184, 185, 231, 238, 239, 240, 242, 243, 244, 246, 247, 248, 262, 263, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 282, 283, 284, 285.
C123, 126, 127, 128, 129, 130, 223, 226, 227, 228, 229, 230.
CR111, 112, 211, 212.
Q104, 107, 204, 207.
U102, 202.

R150, 151, 152, 153, 154, 155, 160, 179, 180, 181, 250, 251 , 252, 253, 254, 260, 279, 280 , 281, 301, 302, 303, 304, 305 , 306, 307, 308, 309, 310, 311 , 312, 313, 314, 315.
C301, 302, 303.
CR301, 302, 303, 304, 305, 306, 307, 308
Q109, 110, 209, 210, 301, 302.
U301.

R401, 402, 403, 404. 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431.
C401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 420, 421.
CR403
Q401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412.

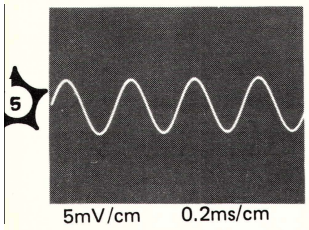


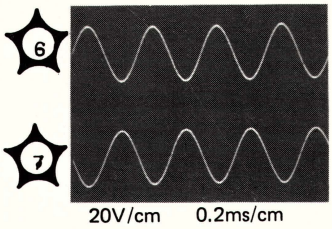
WAVEFORM NOTES

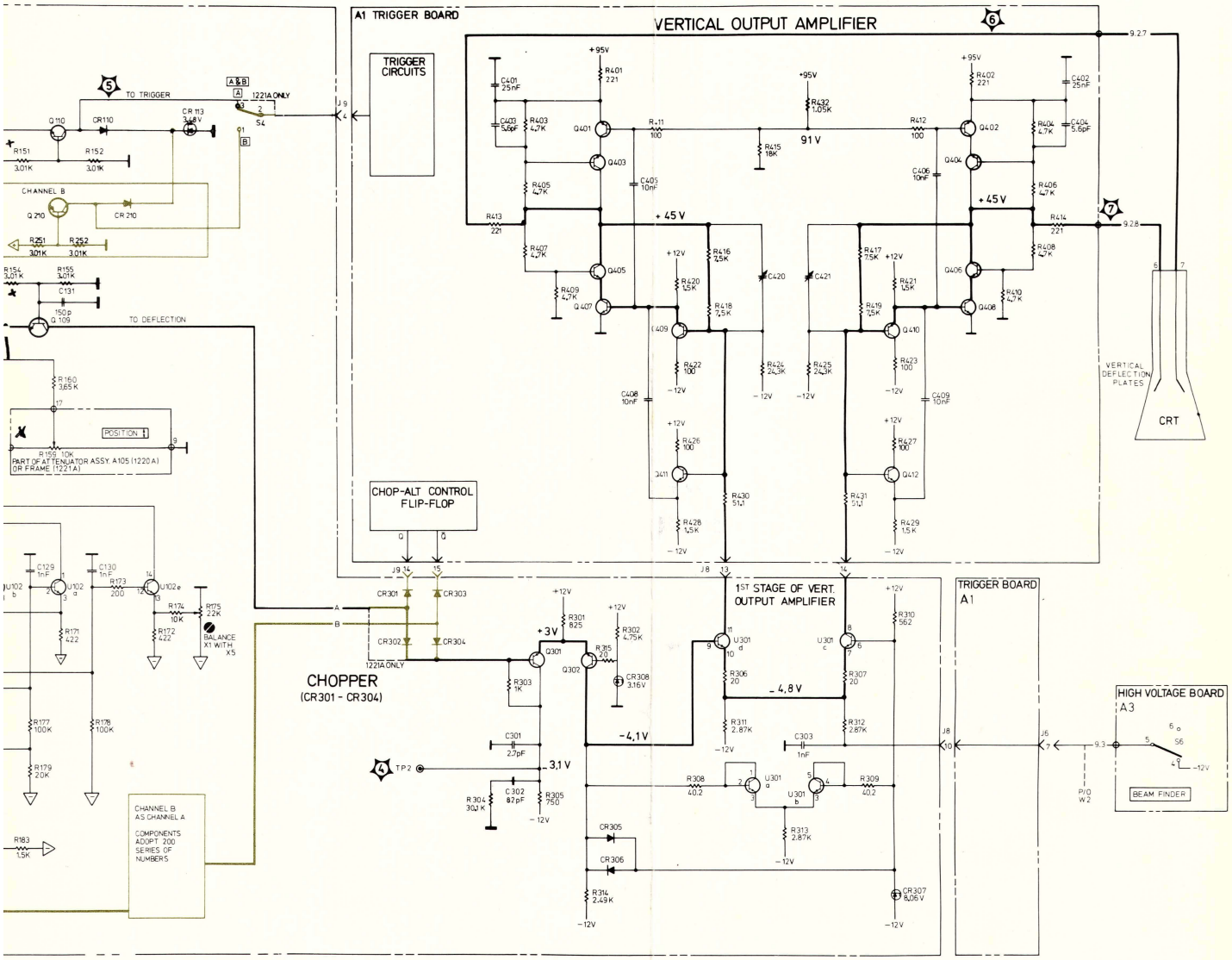
Input Signal: 2kHz, 0.6Vp-p sine wave
Control settings
as figure 2–1 , except:

VOLTS/DIV **19/25**	100mV
TIME/DIV **6**	0.2ms

MONITOR SCOPE
See values below waveforms.







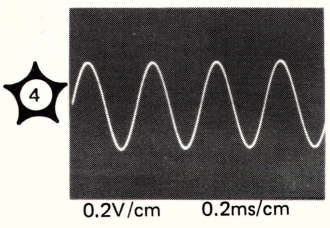
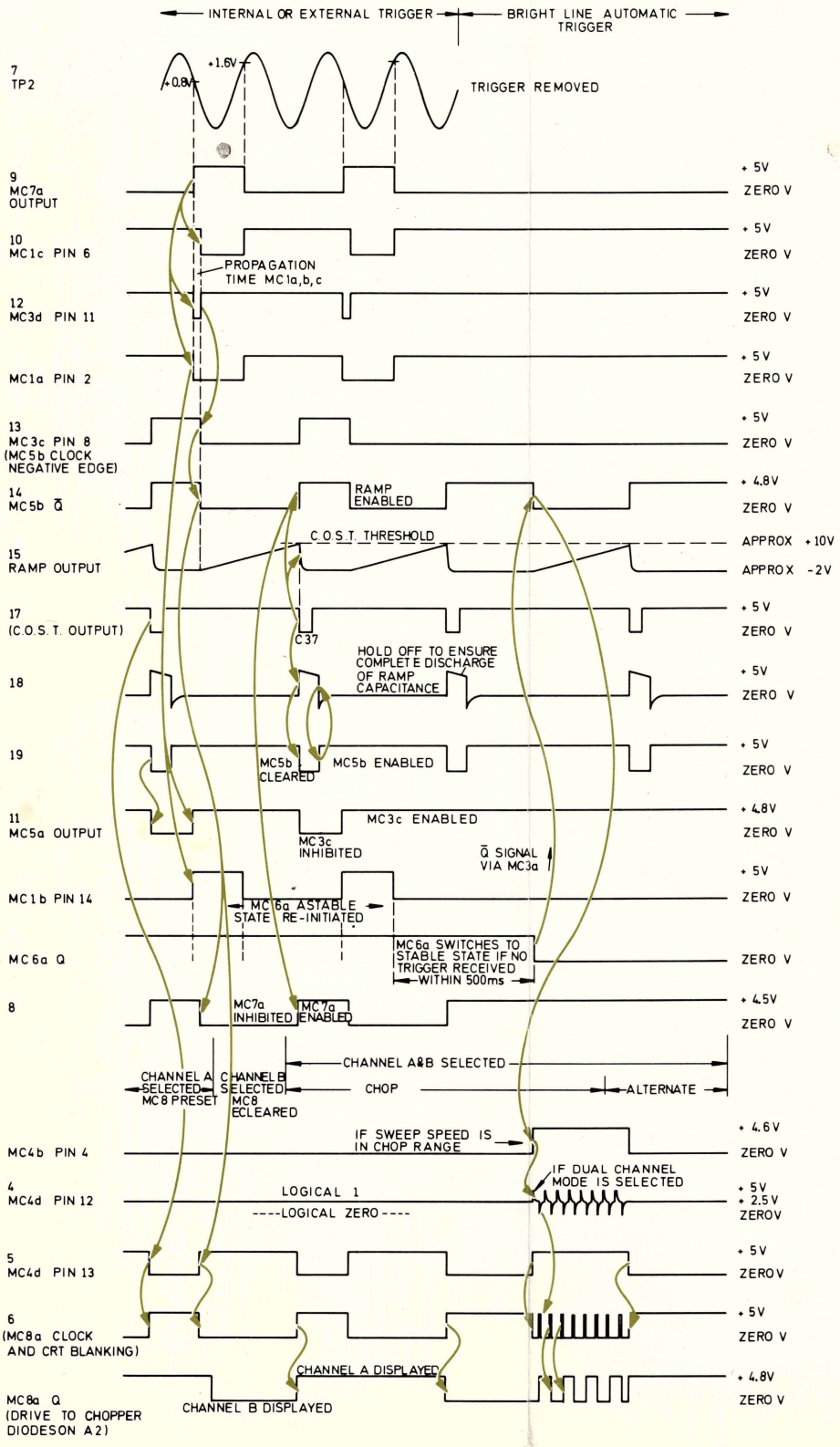


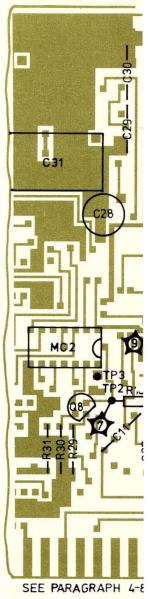
Figure 5–3. Vertical Channels
(Assemblies A105 (205), part A1, part A2)

A1 TRIGGER

EVENT SEQUENCE IN TRIGGER CIRCUIT

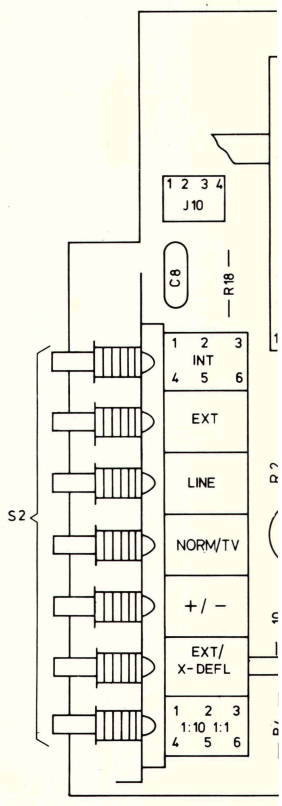
Waveforms are stylized, time axis is not to scale





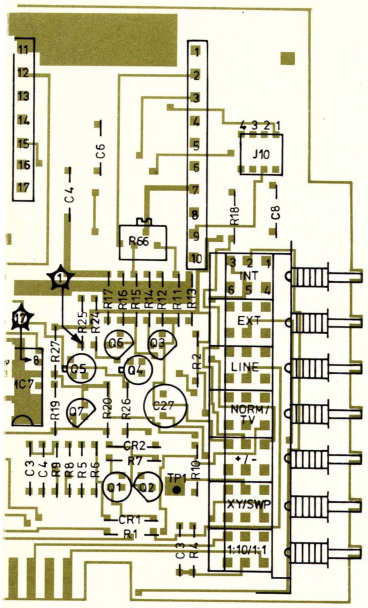
SEE PARAGRAPH 4-6

A1 TRIGGER

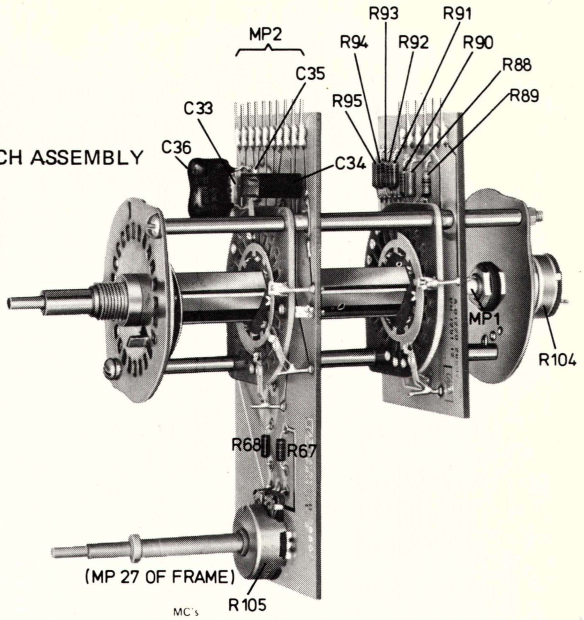


R1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 25, 26, 27, 52, 66.
C3, 4, 5, 6, 7, 8, 27, 37.
CR1, 2
Q1, 2, 3, 4, 5, 6, 7
MC7

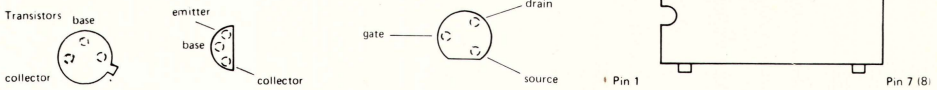
ARD (PART REAR VIEW)



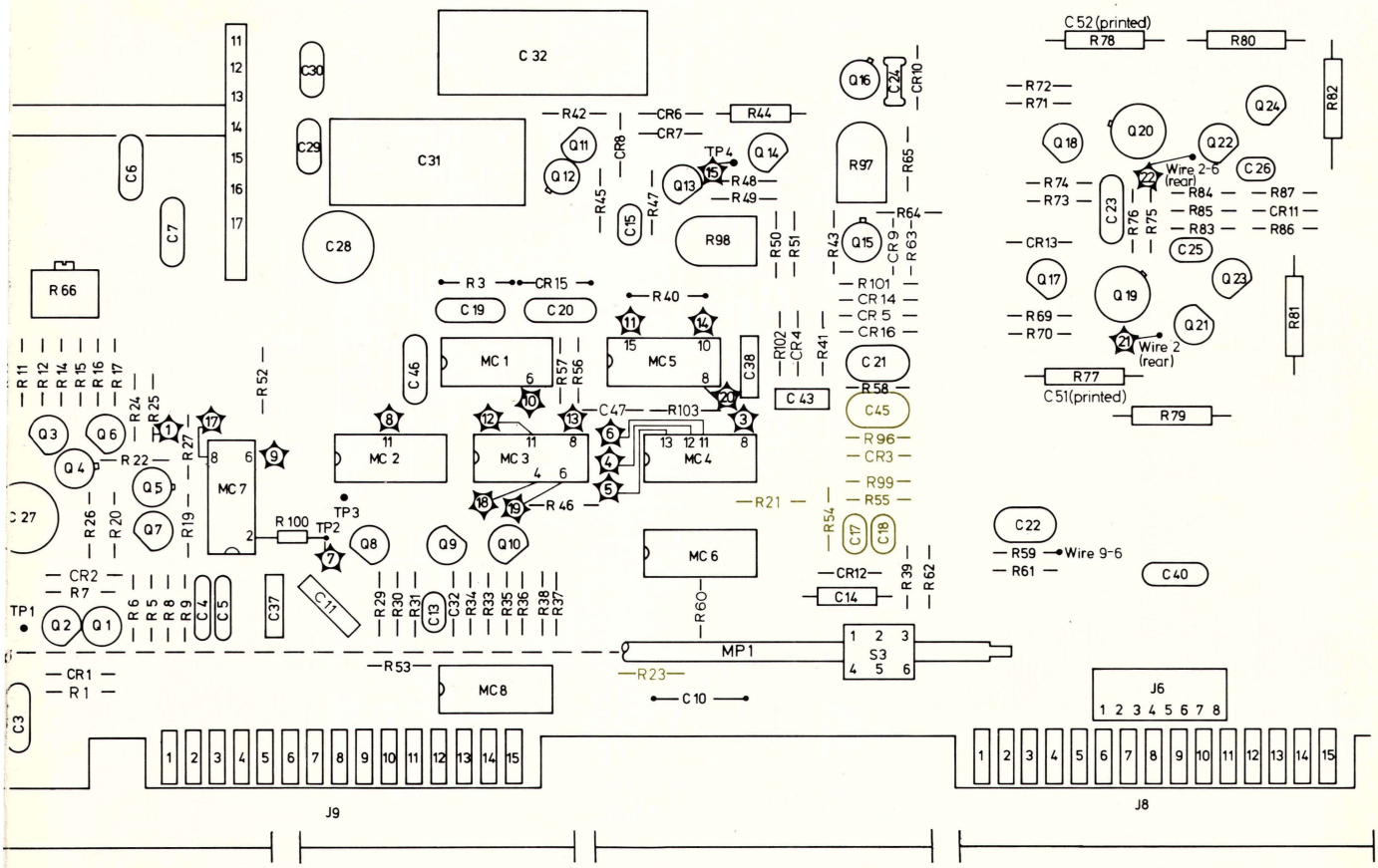
A1A6 TIME/DIV. SWITCH ASSEMBLY



COMPONENTS ARE AS SEEN FROM TOP, ○ REPRESENTS LOCATION OF PIN ON OTHER SIDE



OARD

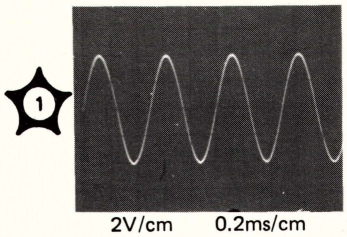


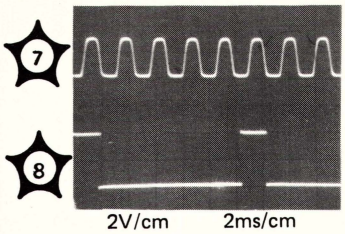
, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24,

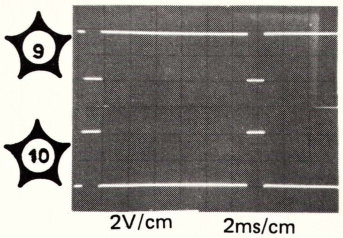
R3, 29, 30, 31, 33, 34, 35, 36, 37, 38, 42, 46, 53, 56, 57, 100
C11, 13, 19, 20, 28, 29, 30, 31, 32, 46,
CR15
Q8, 9, 10, 11, 12.
MC1, 2, 3, 8.

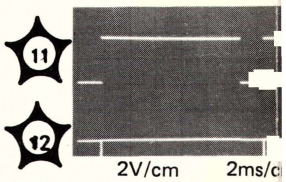
R21, 23, 39, 40, 41, 43, 44, 45, 47, 48, 49, 50, 51, 54, 55, 58, 60, 62, 63, 64, 65, 96, 97, 98, 99, 101, 102, 103.
C10, 14, 15, 17, 18, 21, 24, 38, 43, 45, 47
CR3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 16
Q13, 14, 15, 16
MC4, 5, 6

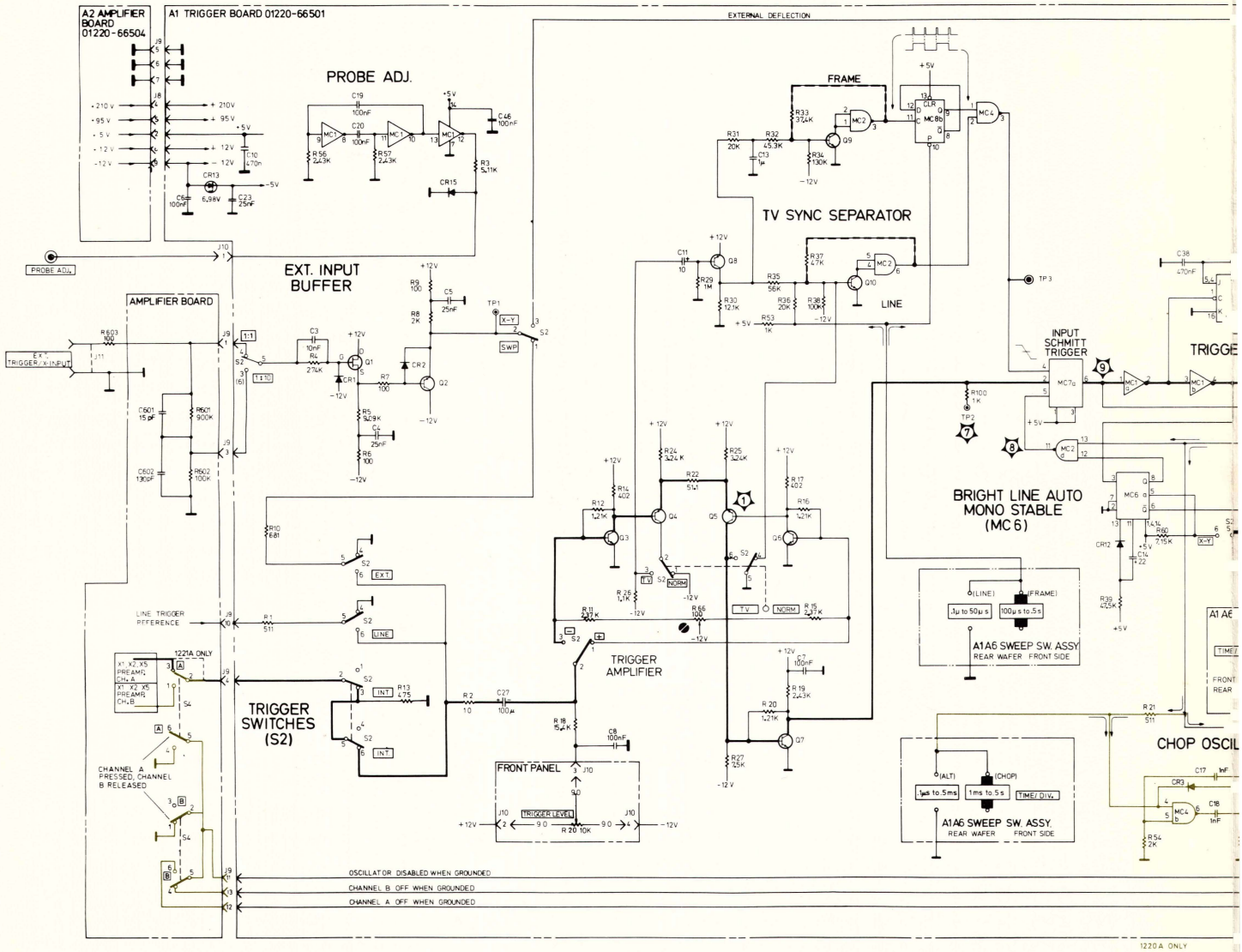
R59, 61, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81 82, 83, 84, 85, 86, 87
C22, 23, 25, 26, 40
CR11, 13
Q17, 18, 19, 20, 21, 22, 23, 24.









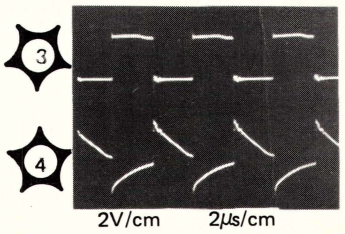


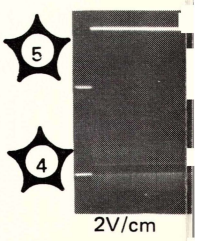
WAVEFORM NOTES

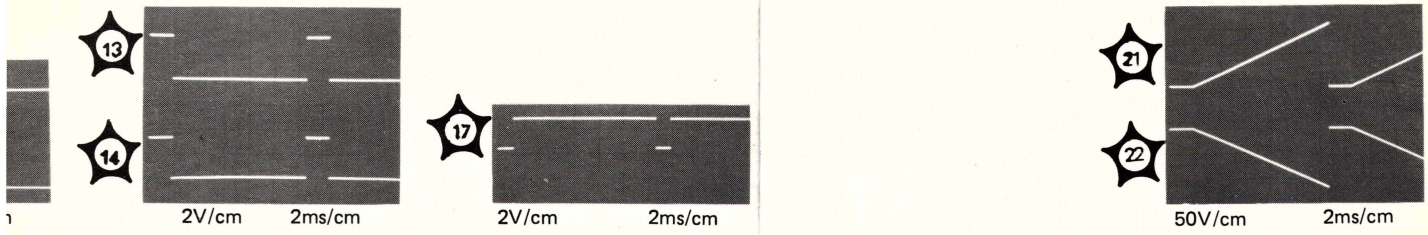
Input Signal: 2kHz, 0.6Vp-p sine wave
Control settings
as figure 2–1 except:

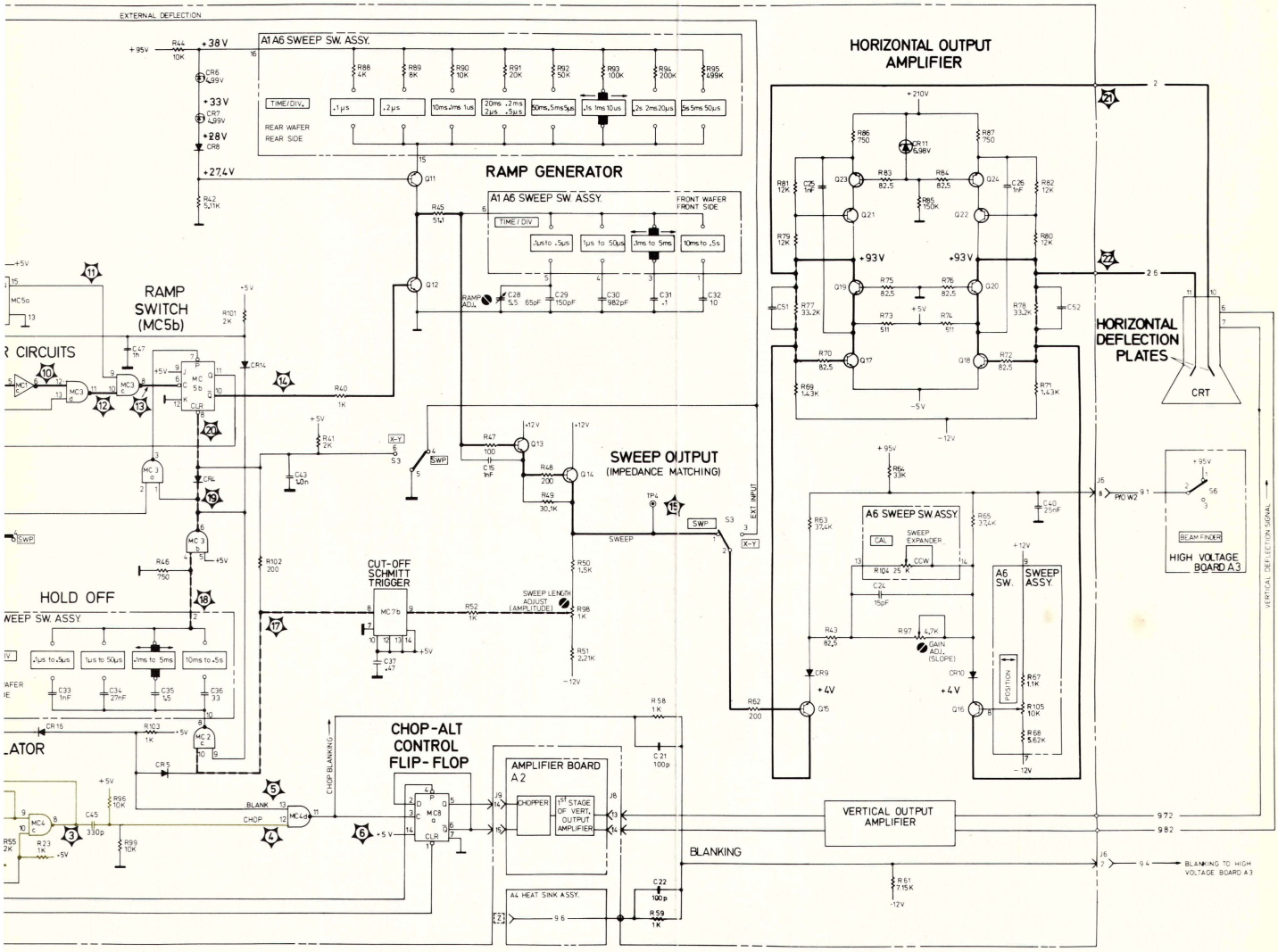
VOLTS/DIV **19/25** 100mV
TIME/DIV **6** 1ms

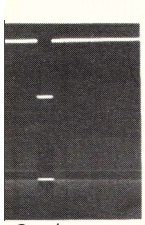
MONITOR SCOPE
See values below waveforms

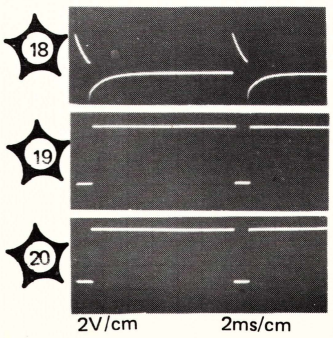


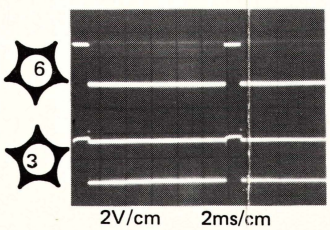


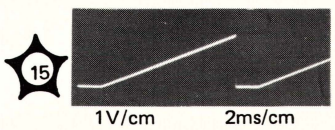












V_{CC} and GND connections	V_{CC}	GND
MC1 to 4	14	7
MC5	5	13
MC6 to 8	14	7

Figure 5–4. Horizontal Channel (Assemblies A1 and A6)

SALES & SERVICE OFFICES

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ALABAMA
8290 Whitesburg Dr., S.E.
P.O. Box 4207
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
2336 E. Magnolia St.
Phoenix 85034
Tel: (602) 244-1361
TWX: 910-951-1330

5737 East Broadway
Tucson 85711
Tel: (602) 298-2313
TWX: 910-952-1162

(Effective Dec. 15, 1973)
2424 East Aragon Rd.
Tucson 85706
Tel: (602) 889-4661

CALIFORNIA
1430 East Orangethorpe Ave.
Fullerton 92631
Tel: (714) 870-1000
TWX: 910-592-1288

3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

6305 Arizona Place
Los Angeles 90045
Tel: (213) 649-2511
TWX: 910-328-6148

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2220 Watt Ave.
Sacramento 95825
Tel: (916) 482-1463
TWX: 910-367-2092

9606 Aero Drive
P.O. Box 23333
San Diego 92123
Tel: (714) 279-3200
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
12 Lunar Drive
New Haven 06525
Tel: (203) 389-6551
TWX: 710-465-2029

FLORIDA
P.O. Box 24210
2806 W. Oakland Park Blvd.
Ft. Lauderdale 33307
Tel: (305) 731-2020
TWX: 510-955-4099

P.O. Box 13910
6177 Lake Ellenor Dr
Orlando, 32809
Tel: (305) 859-2900
TWX: 810-850-0113

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

HAWAII
2875 So. King Street
Honolulu 96814
Tel: (808) 955-4455

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P. O. Box 840
3239 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-9157

20010 Century Blvd.
Germantown 20767
Tel: (31) 428-0700

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (617) 861-8960
TWX: 710-326-6904

MICHIGAN
23855 Research Drive
Farmington 48024
Tel: (313) 476-6400
TWX: 810-242-2900

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087

148 Weldon Parkway
Maryland Heights 63043
Tel: (314) 567-1455
TWX: 910-764-0830

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Las Vegas
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NEW JERSEY
1060 N. Kings Highway
Cherry Hill 08034
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Paramus 07652
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TWX: 710-990-4951

NEW MEXICO
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6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 265-3713
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
6 Automation Lane
Computer Park
Albany 12205
Tel: (518) 458-1550
TWX: 710-441-8270

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

New York City
Manhattan, Bronx
Contact Paramus, NJ Office
Tel: (201) 265-5000
Brooklyn, Queens, Richmond
Contact Woodbury, NY Office
Tel: (516) 921-0300

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

1 Crossways Park West
Woodbury 11797
Tel: (516) 921-0300
TWX: 510-221-2168

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

OHIO
25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

330 Progress Rd.
Dayton 45449
Tel: (513) 859-8202
TWX: 810-459-1925

6665 Busch Blvd.
Columbus 43229
Tel: (614) 846-1300

OKLAHOMA
P.O. Box 32008
Oklahoma City 73132
Tel: (405) 721-0200
TWX: 910-830-6862

OREGON
17890 SW Boones Ferry Road
Tualatin 97062
Tel: (503) 620-3350
TWX: 910-467-8714

PENNSYLVANIA
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Overseas Insurance Corp. Bldg. 7th Floor
Taipei
Tel: 389160,1,2, 375121, Ext. 240-249
Telex: TP824 HEWPACK
Cable: HEWPACK Taipei

THAILAND
UNIMESA Co., Ltd.
Chongkoinee Building
56 Suriwongse Road
Bangkok
Tel: 37956, 31300, 31307, 37540
Cable: UNIMESA Bangkok

UGANDA
Uganda Tele-Electric Co., Ltd.
P.O. Box 4449
Kampala
Tel: 57279
Cable: COMCO Kampala

VIETNAM
Peninsular Trading Inc.
P.O. Box H-3
216 Hien-Vuong
Saigon
Tel: 20-805, 93398
Cable: PENTRA, SAIGON 242

ZAMBIA
R. J. Tilbury (Zambia) Ltd.
P.O. Box 2792
Lusaka
Zambia, Central Africa
Tel: 73793
Cable: ARJAYTEE, Lusaka

MEDITERRANEAN AND MIDDLE EAST COUNTRIES NOT SHOWN PLEASE CONTACT:
Hewlett-Packard
Co-ordination Office for Mediterranean and Middle East Operations
Piazza Marconi 25
I-00144 Rome-Eur, Italy
Tel: (6) 59 40 29
Cable: HEWPACKIT Rome
Telex: 61514

OTHER AREAS NOT LISTED, CONTACT:
Hewlett-Packard
Export Trade Company
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 326-7000
(Feb. 71 493-1501)
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8300, 034-8493

HEWLETT hp PACKARD

CATHODE-RAY TUBE WARRANTY

The cathode-ray tube (CRT) supplied in your Hewlett-Packard Oscilloscope and replacement CRT's purchased from hp are warranted by the Hewlett-Packard Company against electrical failure for a period of one year from the date of sale. Broken tubes and tubes with phosphor or mesh burns are not included under this warranty. If the CRT is broken when received, a claim should be made with the responsible carrier.

Your nearest Hewlett-Packard Sales/Service Office (listed at rear of instrument manual) maintains a stock of replacement tubes and will assist in processing the warranty claim.

We would like to evaluate every defective CRT. This engineering evaluation helps us to provide a better product for you. Please fill out the CRT Failure Report on the reverse side of this sheet and return it with the defective CRT to:

Hewlett-Packard Company
1900 Garden of the Gods Road
Colorado Springs, Colorado 80907

Attention: CRT QA

To avoid damage to the tube while in shipment, please follow the shipping instructions below; warranty credit is not allowed on broken tubes.

SHIPPING INSTRUCTIONS

It is preferable that the defective CRT be returned in the replacement CRT carton. If the carton or packaging material is not available, pack the CRT according to the instructions below:

1. Carefully wrap the tube in 1/4 inch thick cotton batting or other soft padding material.
2. Wrap the above in heavy kraft paper.
3. Pack wrapped tube in a rigid container which is at least 4 inches larger than the tube in each dimension.
4. Surround the tube with at least 4 inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.

Thank you,

CRT Department

HEWLETT hp PACKARD

CATHODE-RAY TUBE FAILURE REPORT

DATE _____

FROM:

NAME _____

COMPANY _____

ADDRESS _____

1. hp INSTRUMENT MODEL NO. _____

2. hp INSTRUMENT SERIAL NO. _____

3. CRT SERIAL NO. _____

4. Please describe the failure and , if possible, show the trouble on the appropriate CRT face below.

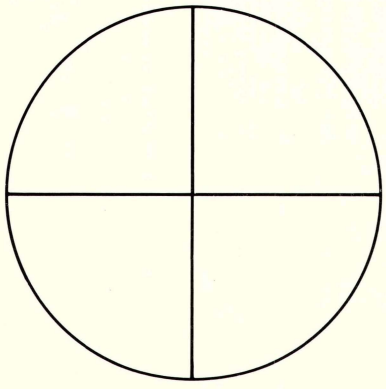
_____

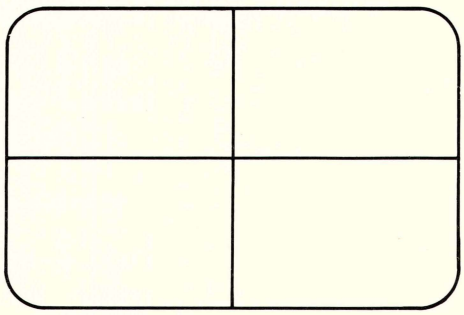
_____

_____

_____

_____





5. Is the CRT within warranty ? Yes _____ No _____

6. hp Sales/Service Office _____ Repair Order No. _____

PLEASE TEAR AWAY

HEWLETT hp PACKARD

01220–90001

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